ELECTRICAL WORLD

A consolidation of Electrical World, Electrical Engineer and American Electrician

What in the World!

All is not gold that glitters. The citizens of Birmingham voted down a proposition to go into the utility business even though the Muscle Shoals power propaganda was exerted in full force. Loss of taxes at present paid by the utility, a large bond issue, increased local taxes and the impossibility of the city making any money out of the retail rates announced by T.V.A. all contributed to the negative result. It is also astounding to find that only 10 per cent of the citizens were sufficiently interested to vote even after an acrimonious campaign. Maybe other cities will also say no to the Tennessee siren.

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Supervisors for the N.E.M.A. code are to be announced shortly. These men will undertake a difficult task under trying conditions. It should be remembered that their services are donated in a desire to help the industry and the administration. Cordial support should be given them in their efforts to make the code operative. They will need and should receive the help of all the industry units.

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Much talk and little action has come from Washington about aiding the revival of business in the heavy industries. About all that may be done by the administration is to make money available on easy and long terms, but present efforts to do this take the indirect form of forcing an expansion of bank credit. This will not work. Banks will not loan depositors money on long terms under present unsettled monetary conditions. Taxpayers' money and not depositors' money must be made available. But beyond this the capital goods industries must be shown that spending this money will give them profits instead of greater deficits. This is not easy.

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Reports indicate that the lighting campaigns are going splendidly. Business is beyond the most sanguine expectations in those com munities where the industry got behind the movement. It is not too late for other localities to get busy and participate in profits. We hope to have some detailed reports shortly showing how to sell light and the results that have been obtained through work in a co-ordinated program.

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ELECTRICAL WORLD

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for the Week Ending

October 21, 1933

L. W. W. MORROW, *Editor*

Only Teamwork Will Win

PROSPEROUS and expanding light and power utilities are necessary to the success of the electrical industry and to sales to the electrical markets in this country. Under present trying conditions electrical men are apt to forget this fact. They are apt to be inert, to pass the buck and to fall into errors in their thoughts and actions so that the unity and teamwork essential to overcoming the obstacles confronting each branch are not available. Disaster to one group in the electrical industry means disaster to all.

Even in utility circles there is a lack of understanding and an absence of co-operation. Holding company executives and the operating property executives pass the buck back and forth and try to pin both blame for present conditions and an absence of remedial action on each other too frequently. Commercial men are too prone to complain of lack of sympathy from executives with their plans for getting more business or for holding present business. Engineers also are rather inert and apathetic because of lack of expansion, the firing of many of their associates and orders to spend no money. These conditions make for poor morale and prevent the recovery of utility prosperity and more sales to industry markets. Smiles must replace frowns.

There should be more understanding within utility ranks; there should be mutual concessions; there should be more willingness to assume responsibility instead of eagerness to pass it on; there should be a greater realization that only by co-ordinated and co-operative action can conditions be improved. Executives on operating properties should realize that they are an essential part of the industry, and in addition that holding company executives also are essential elements in the business as now constituted; both types of executives have many vital problems to solve. These executives must understand each other better and must get together. They must make mutual concessions and work out a common policy that they will help put into operation. They must make this policy known to all employees and to the other branches of the industry so that conscientious and powerful support will be had. The time has come to quit blaming the other fellow; for constructive work to replace fractious criticism; for unity based upon understanding.

Under the surface of the superficial and very human reactions to the present utility conditions all know that the vast majority of men in the industry are honest, conscientious and able. That from holding company executive down to office boy all are anxious to succeed, to build the business, to improve public relations, and to be relieved from the present privations and persecutions. The external pressure from a hostile public should force unity in utility ranks, and this should come about through understanding arrived at by forbearance, concessions to the other fellow's point of view, a common knowledge of all industry problems and a definite program for their solution.

And the other branches of the industry should also act upon the thought that a prosperous utility is necessary to their business. Promotion of the electrical idea, facilities for supply-

ing service, development of new business, co-operation in the markets—utility facilities and utility aids are necessary to all. Too frequently, however, manufacturers, wholesalers, contractors and retailers take a "crack" at the utilities upon every possible public or private occasion and thus help to undermine the utilities and weaken their possibilities for aiding them in their own sales. Such actions are thoughtless, and however much to blame the utilities are for not taking these branches into their confidence, here again a clearer perspective and a keener analysis of the situation would dictate a different attitude and more constructive action. Teamwork, based upon an understanding of the other fellow's problems and points of view and a common business objective, is the program of the industry with respect to the utilities.

End of the S.E.D.— What of co-operation?

News that the Society for Electrical Development is now to be dissolved comes several years too late, but is none the less welcome. It was a reproach to the name of co-operation and a scandal in the industry that, having failed to accomplish anything in their final effort to make the S.E.D. a co-ordinating agency and an industry forum, the four national associations did not face their failure, admit it and have done. To let the society drag along powerless but pretending was not only a waste of money but a discouragement to the vital cause of co-operation.

The passing of the S.E.D. is no repudiation of the ideal for which it was formed. It simply means that the machinery which men set up to promote it has broken down. And it has broken down, not for lack of opportunity nor the loyalty of many men, but fundamentally because the dominant branch of the industry has not yet been ready to take its place in the harness of this four-horse team and start down the road with the industry's load. And perhaps this is just another way of saying that the S.E.D. has never set up sufficiently comprehensive and appealing programs to capture this support and to weld the industry solidly together behind these objectives.

It is a good thing to clean up the wreck and clear the track. For the electrical industry cannot go forward without organized co-operation between the power companies, manufacturers, wholesalers, contractors and dealers. And so one of these days another co-ordinating agency will be set up by the four associations under new leaders. We will bury the S.E.D. and forget the disappointments. But let's remember that the ideal will not die. It marches on and will some day prevail.

Out on a big limb

The first error in the Tennessee Valley plan was the endeavor to sustain it upon the basis of electric power. The second was the announcement of retail rates and the endeavor to sell municipalities the idea of going into the power business at these rates. And now the results of the Birmingham election promise to show the fallacy of these conceptions. If the large cities in the area refuse the power under the prescribed conditions the entire project becomes a sinkhole for taxpayers' money—a power station without any load.

Birmingham was a fair test sample. Under the Alabama law the utility could not participate in the campaign and the municipality could borrow the money needed. Proponents of municipal ownership waged a very active campaign. After all that was said and done the people were unconvinced that rates could be lowered appreciably and they were convinced that taxes would increase and that there would be losses instead of profits if they went into the utility business.

Up in Cincinnati on November 7 there will be another election on municipal ownership to use T.V.A. power. The situation is different here; it started with a fight on gas rates, a hurried valuation and recommendation as to rate reductions by a consulting firm, and the T.V.A. brought into flame a smoldering fire. Here again the utility is prevented by law from participating in the campaign, while the fervent advocates of municipal ownership are free to act. And their statements are so full of flaws that they defeat their purpose. It is anticipated that sane public sentiment will express itself as it did in Birmingham—the people understand increased taxes, more bond issues and the waste involved in political operation.

THE WEEK

Birmingham Vote Discourages T.V.A.

All is not going so well with the Tennessee Valley Authority. The sound conception of a slow development in the mind of Dr. Morgan is faced by administration pressure to speed up work and spend money. In addition, the people in the valley are demanding action. On top of this the voters in the Birmingham election removed the possibilities of a load from the largest city in that area. The vote on October 9 revealed widespread antagonism against T.V.A. With the same issue coming up in Knoxville November 25, Dr. Morgan remarked that if the T.V.A. power project is to be a success it must have a market. He said:

"It lies in the hands of the people of the region. It is not our place to campaign in local elections, but only to make it very clear what the issue is."

Dr. Morgan explained that T.V.A. needs one large town in order to establish a stable market. Birmingham, Memphis, Louisville, Knoxville, Cincinnati, possibly Pittsburgh or Atlanta.

"It doesn't make much difference which, and if we get one, that's enough."

T.V.A.'s program now is developing in other directions. A "representative commercial process" for the manufacture of fertilizer will be set up as a demonstration to private industry. Funds have been allotted to Dr. S. G. Cottrell of the Fixed Nitrogen Research Laboratory in Washington for designing a blast furnace for the reduction of phosphate rock. Phosphate is regarded as the prime constituent of any fertilizer for the valley's leguminous crops. Local potash shales may be used as a flux in the phosphate smelter, but for the present T.V.A. will buy potash needed in a mixed fertilizer. Records of its value as a plant food will be kept on all fertilizer distributed, as the mechanical as well as chemical characteristics of the product are regarded as important.

Dr. Harry A. Curtis, T.V.A.'s chief chemist, now is at Muscle Shoals preparing plans for the manufacture of nitrate by the cyanamid process. There have been tentative inquiries but, according to Dr. Morgan, there has been no evidence of a firm offer from the American Farm Bureau Federation, to which the law permits lease of the plant. Several inquiries have been received by T.V.A. concerning exploitation of the valley's resources in the production of aluminum, iron, beryllium and manganese.

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Bond & Share Group Protests Utilities' Burdens

Disgruntled over the high taxes imposed on utilities, the agitation for rate reductions and government-ownership problems, a group of stockholders of the Electric Bond & Share Company has organized a committee to formulate plans for a nation-wide organization to protect utility security holders. The meeting was held last week after the officers and directors of Electric Bond & Share had withdrawn following the company's regular annual meeting. Martin T. Flannigan, an insurance and real estate man, was chosen chairman of the committee, and other stockholders, all of whom said they had no official connection with utility companies, agreed to serve on a ways and means committee which will seek to obtain the support of security holders of all public utility companies.

Companies in the Electric Bond & Share group at present have more than $174,800,000 in cash in banks, United States government securities and bankers' acceptances, it was revealed at the annual meeting, cash holdings of Electric Bond & Share alone amounting to $48,858,100 on October 10, comparing with $41,203,812 on September 30, 1932. Compared with the cash resources of the group, only two of the holding companies have any bank debt, C. E. Groesbeck, chairman of the board, said, these being the United Gas Corporation, which has $21,250,000 notes, due July 20, 1936, and American & Foreign Power Company, Inc., which has $50,000,000, due October 26, 1933. Negotiations for extension of this loan are being undertaken. None of the domestic operating companies has any bank debt and only three of the foreign operating companies are indebted to banks, for an aggregate of $521,500, nearly all in Argentine pesos.

George H. Howard, president of the United Corporation, resigned as a director of the company and in view of a previous vacancy on the board P. E. Cowan of the law firm of Simpson, Thacher & Bartlett and E. P. Summerson, secretary of the company, were elected directors.

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Lilienthal Tells About T.V.A.

Says rates are fair.
Discourages organization of utility investors.
Offers to co-operate with utilities.
Solicits support of Memphis.

IN AN address on October 17 at Memphis, David E. Lilienthal of the Tennessee Valley Authority explained the power program of the Authority. The essential features of his address are in the following abstract:

The power program of the Authority is an important part of its present plans and of the long-range regional program. The starting point in any discussion of this power policy and program must be this: That the distribution of electricity is not like the usual private business, but, in the language of the ancient common law, is a business "affected with a public interest." By its very nature, the business of generation and distribution of power is a public business, because in our present-day community life we are all so utterly dependent upon that service. We need constantly to revert to this fundamental principle of the public character of the electric business.

Is it any wonder then that the people are determined to maintain the most vigilant public control of this liberating force? Various expedients for the public's protection have been adopted. One is regulation by state commissions. It is generally recognized that such regulation has not been entirely adequate to protect the public interest. And so, to supplement regulation, Congress has provided for a measure of public operation on a limited scale. This public operation is to serve as a yardstick by which to measure the fairness of electric rates. It has an additional function. It is a reminder that electricity performs a public service and that unless it is exercised by private corporations with fairness, with efficiency, without financial jugglery and with a due sense of responsibility to the paramount public interests involved, that the public, at any time, may itself assume the function of providing itself with this necessity of community life.

This power program is a constructive measure. **Congress has not declared a national policy against the private ownership and operation of public utilities. It has rather provided for an additional measure of public protection against abuses in the conduct of a business which, by its very nature, is a matter of fundamental public concern.**

What the Authority is required to do in its power program is to set up an area for power operations which will be on a comparable basis with typical private operations. To set up such a "yardstick" the Authority obviously must undertake to serve an area which is large enough and sufficiently concentrated, with enough population density and with a sufficiently diversified industrial, commercial and residential load to provide a fair test. As business men, it is apparent to you that if the Authority is only to serve the parts of a territory which a private utility has not chosen to serve, or is to serve only sparsely populated areas, the result of our operations cannot possibly be set up as a measuring rod. The Authority will necessarily have to undertake to serve a balanced area of concentrated industrial activity, including some cities of substantial size, good farms and reasonably favorable distribution possibilities.

Basis of rates

The board of the Tennessee Valley Authority some weeks ago directed the formulation of wholesale rate standards to form the basis for contracts for power with municipalities and other agencies within the yardstick area. Since the statute imposes a measure of responsibility upon the Authority for the rates charged to the ultimate consumers of electricity, a proposed schedule of rates to the householder and farmer was also worked out. It was anticipated, of course, that the proposed basic rates, like any other standard, must be adapted to the varying conditions which exist in a highly diversified area.

First of all, we kept in mind that the consumers of Muscle Shoals power must pay all the costs. In short, the power program of the Authority is not to be subsidized by the taxpayer. And in the second place, to carry out the President's plan for a "yardstick," all costs of a comparable privately owned company were considered, as accurately as possible. This included direct operating expenses and administrative overheads, interest, depreciation and taxes. In addition to costs, we planned a program of retiring our fixed capital out of revenues, so that in a period of years fixed charges would be reduced and rates could be made even lower. As investors in street railway bonds will recall with some pain, public utilities do not make provision for the retirement of capital obligations as they mature. The Authority's plan is therefore in the direction of more conservative business practice.

The item of taxes in public power operations has been the subject of confusion and misinformation, and I would like to discuss it for a moment. The principle, as I see it, can be worded in this way: A public power system should bear the burden of taxes which it would pay if it were privately owned. A public power system should contribute its share of taxes to the general fund. This has for years been the established practice in well-managed public power enterprises. And, conversely, the taxpayers should deal fairly with the funds of a public power system, and not load upon the electric system, that is the ratepayers, the general costs of government. In the experience of commissioners responsible for the regulation of municipally owned plants, the tendency is for the taxpayers to take too much out of the power system at the expense of consumers, rather than the reverse.

The principle that a public power enterprise should bear its share of taxes has been observed in the computation of the Authority's standard for a wholesale rate. The statute under which we operate provides that a tax of 5 per cent of annual operating revenues derived from power generated in Alabama be paid to that state, and when power is generated at the new Norris Dam in Tennessee taxes will also be payable to this state on the same basis. The Authority is subject to no other taxes. But we wanted to make a fair comparison by taking into account in determining our operating expenses the item of taxes which private utilities must pay. Accordingly, we got the latest figures on the average percentage of gross revenues which private utilities throughout the country paid in state, local and federal taxes and used this figure as the basis of our tax expense item.

Another item of expense which was considered in computing the Authority's standard for wholesale rates was that of interest. Actually the Authority has no obligation to pay interest since it has not issued any bonds. The Muscle Shoals property was built, you will remember, with funds which were raised to carry on the war. But in order to provide an unquestionable fair comparison with private operations we set up interest expense at the rate the government would have to pay for such capital.

There are a number of other factors in the computation of these rates which are of interest. Suffice it to say that a careful effort was made to consider all items of expense of comparable private operations and to treat the entire project as a self-supporting project and not as a taxpayer's subsidy. **If Muscle Shoals power is sold in volume at the Authority's rates, every conceivable item of cost will be covered, and in addition, the Authority can pay back into the Treasury, and therefore in a sense to the taxpayers all over the country, the sums appropriated from the Treasury for this enterprise.**

I suppose it is obvious that all computations concerning costs are based on the expectation that the Authority will sell the power which it has available. Muscle Shoals was turned over to us as a going plant, but not as a going concern with customers. Obviously, if we sell only one kilowatt-hour our cost will be hundreds of thousands of dollars a kilowatt-hour, rather than a few mills. If the power is not utilized in volume, no one will receive the great potential benefits of the wealth of the Tennessee River. It is axiomatic in the electric business that an increase in use decreases the cost per unit of output. Accordingly, we look forward to a maximum use of our facilities, because it is in that way that the Authority and those agencies which buy its power at wholesale can steadily bring down rates to the householder, the farmer and the business man and bring to this area the economic and social benefits of the President's plan.

Effect upon utility investors

What is going to be the effect of the Authority's power program on the investor in public utility securities? Here is an acute and difficult question, and one which I have no desire to evade.

The Authority is not engaged in a punitive expedition against the utilities. The Authority is an instrument of the people of the United States. It is charged with the duty of carrying out a national power policy, and the safeguarding of the public interest in the country's greatest resource, profoundly affecting the future development and prosperity of our country and all of its people. This policy has not been formulated overnight. It is not a mere political accident. It represents more than a decade of careful consideration. It has been thoroughly debated in the Congress of the United States; it has been sponsored by the President of the United States. The power program of the Authority is an integral part of a larger policy for the economic development of the United States.

The duty of the Authority is to carry out that policy. But in carrying it out the Authority is determined to bring the least possible injury to actual investments in useful property.

This is not the first time that the execution of a great national purpose has adversely affected private interests. Many examples will come to your mind. There was a time many years ago, for example, when the educational system of the country was in private hands. The problem implicit in the Tennessee Valley Authority act is essentially the same. Once the representatives of the people and their President have determined that the national welfare demands the setting up an example of public power operation in this area, is it the part of loyal Americans to seek to destroy and to thwart that policy merely because they fear that it may adversely affect their private holdings?

The times call for the ablest leadership in the electrical industry. And as I well know, there are men in that industry who have the capacity for genuine statesmanship. But if instead of such level-headed leadership we have hysteria a refusal to look at the facts, or a resort to underground methods or misrepresentations, then the electrical industry, its investors and the general public will inevitably suffer. In the most matter-of-fact terms the Authority has announced a standard for rates in which every item of cost to which private utilities have been subjected has

A Pass, a Punt, a Prayer

The quarterback still calls signals and pushes his perspiring teammates with unabated vigor. But the ball still remains in the middle of the field. Old plays such as the codes, open market operations and public works construction continue to gain yardage. New plays have been used to bring the capital goods industries into action. The fire and the will to victory remain, but it is difficult to get into a scoring position.

The opponents are strong on defense. Labor, security holders, farmers, business men and home owners stubbornly contend against an attempt to push them away from their present positions. There is little teamwork, but the individual opponents are heavy and strong. The battle of recovery is still a kaleidoscope.

Forgetting the football analogy, we are on a flat recovery plateau. General business just about holds its own. Bargain hunters dominate in retail sales and cause a slight drop in volume. Stocks and bonds hold level. Commodity prices still rise. It becomes increasingly evident that capital goods industries must be revived if the recovery is to continue. The administration is trying to do this by (1) speeding up public works, (2) releasing the money held by closed banks, (3) continuing open market operations, (4) forming mortgage loan companies, (5) making equipment loans to railroads, (6) suggesting a possible modification of the securities act. Results from these actions will be very slow; business itself must add to the program.

Utilities feel better. The meeting of the commissioners was a tonic. The Birmingham election reflected itself in the security markets. Loads continue to hold up quite well. Many evidences of a more favorable public sentiment come to light. Manufacturers are still wondering what it's all about. They have a code, but it is not in operation as regards trade practices. Wages and taxes are increased, labor troubles continue and business volume remains stationary. The construction season is passing rapidly and orders are still few and far between. Appliance sales are good and sustain the volume in manufacturing.

Present conditions should have been expected. There is a very positive negative reaction to many aspects of the administration's program, there is a growth of criticism, some things have worked out well, others have caused troubles, still others have failed. But these aspects of the present situation should not outweigh the positive gains and the future possibilities. The pressure of the administration still exists and the program has been modified and strengthened. The mass of the people are back of it. The chances are bright for a continued recovery this fall.

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been included. That rate announcement has been interpreted as an opportunity to the people of this region to secure power at lower rates than are now being charged. If it is a crime to carry out the will of Congress and the President, without recrimination, without appeals to emotion or prejudice, if it is a crime thus to work toward lower power rates which will promote the industrial and economic welfare of this area, then I, for one, am happy to plead guilty.

You are probably aware that there is a movement on foot to organize the security holders of the country to put a stop to this whole project. Among the utility holders are thousands of people of modest means, as well as institutional investors. An effort to organize security holders into an army to do battle with the consumers of electricity raises a serious question which should be faced with frankness. If I were concerned merely with the success of this project, such a program would seem advantageous, because, of course, the consumers far outnumber, numerically and in political strength, those who receive dividends. But the consequences to society of pitting the owners of property against the users of property at a time of great distress and bitterness against the more fortunate members of the community is a policy of "rule or ruin" which should be frowned upon by every one who realizes the seriousness of the situation. If such a marshaling of security owners leads consumers to feel that the benefits of cheap electricity are denied them by the organized influence of investors, the result may be a bitterness against investors in utility securities on the part of great masses of people. I can conceive of nothing which would more surely threaten the future of private ownership of public utilities than such an event. Such a course of action may prevent that moderate statesmanlike determination of this question, which the Authority earnestly desires, in which legitimate private interests can be protected and the will of Congress carried out.

To you who are investors in public utility securities, I want to speak very frankly: After long deliberation, a national policy has been determined upon whereby a limited example of public operation of the power business is to be set up and to be given a chance to show what it can do. This is now the nation's policy. That national policy should have a fair chance. **The Authority is ready to sit down with the leaders in the electric industry and discuss their respective problems as business men, and as men who above all other considerations are loyal to their government and to their President at a time of grave crisis.** I appeal to the electrical industry on behalf of the investors to whom it is responsible to show a measure of business leadership which will make the country forget the disgrace which was cast on the industry during the past decade. Never was there a time in the notable history of the electrical industry when there was greater need for calm and statesmanlike qualities on the part of the industry and on the part of government, and when hysteria, bitterness and appeals to prejudice or cupidity were more hazardous to investors and consumers alike.

Granted a leadership equal to its responsibilities, the holders of public utility securities, which represent actual prudent investment, are in a favorable situation, compared with investors in almost any other industry. There are few companies in other industries which have maintained and in some cases even increased their earnings during the depression as the electric utilities have been able to do. The demand for power is steadily increasing. It has been estimated that in ten years the electrochemical industries will be consuming thirty billion kilowatt-hours a year, which is about one-third of the total power generated in the United States today. There will be room for both private and public operations and both can succeed if fair dealing and moderation prevail over councils of warfare and malice.

Here is an opportunity for industry and for government to display qualities of statesmanship. The Authority must carry out the national policy intrusted to it. It must acquire a market for its power. It must work toward a wider use of electricity in the home, the farm and the factory. All of these objectives can be reached without the predicted calamities to the industry and its bona fide investors. If the Authority succeeds in its plans to develop new uses for electricity, and by low rates and wide distribution of low cost appliances can increase existing uses, private utilities and the electric manufacturers can both share in the benefits. **If in acquiring a market we can use existing facilities of private utilities, of course we will pay a fair price for them.** By contracts with private utilities for interchange of power, economies and service betterment can be effected in which the utilities will derive benefits. I could cite other concrete instances to the same point. If there is a genuine desire to work **with** this project and not to obstruct or destroy it, ways and means can and will be found for the electrical industry and government to work without friction in expanding the use of electrical energy for the benefit of all of our people.

As a new neighbor of yours, I appeal to you not to permit this opportunity for national leadership to fail through any lack of your support. I appeal to you to refuse to listen to the voices of those of little vision and of selfish purpose. This program will succeed only if you of the area treat this as a national project. I appeal to you to throw your energies and devotion into this national program, which can mean so much to you and to your children.

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Pumped Storage in Austria

Plans for a 260,000 kw. hydro station to be known as the Payerbach-Bodenwiese plant have been prepared in Austria. This station would utilize a mountain basin at an altitude of 2,300 ft. above the adjacent Schwarzabach valley as a pumped storage reservoir.

Coming Meetings

American Society of Mechanical Engineers—New York, N. Y., December 4-9. C. W. Rice, 29 West 39th St., New York.

American Physical Society, Pacific Coast Meeting—Stanford University, Calif., December 15-16. W. L. Severinghaus, Columbia University, New York.

American Institute of Electrical Engineers—New York, N. Y., January 23-26. H. H. Henline, 29 West 39th St., New York

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Supreme Court Denies Texas Utility Review

Review of a lower court decision was denied the Texas Electric Service Company last week by the U. S. Supreme Court in a suit with Fairbanks, Morse & Company involving the former's attempt to prevent the latter from inducing customers of the electric company to breach their contracts by causing them to sign contracts for the same service from a proposed municipal plant before their contracts expire (ELECTRICAL WORLD, August 19, page 227). The Fairbanks, Morse Company is engaged in selling machinery used in power plants, including municipally owned plants. It devised a plan of conducting its business under which it contracts with city authorities to construct and equip municipal plants, the purchase price of same to be paid out of the net profits of such plants, the Texas Electric company stated in its brief.

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Governor Park Recommends Municipal Plant Law

Authorization for the erection or purchase of municipal plants throughout the state of Missouri is sought in the legislative program formulated by Governor Park for enactment at the special session of the Legislature recently called by him. The proclamation, calling upon the general assembly to consider and enact such legislation as may seem proper, said in reference to municipal plants: "To authorize any city, town or village now or hereafter having a population of less than 75,000 inhabitants to purchase, construct, establish, erect, maintain and operate, either within or partly within and partly without the corporate limits of such cities, towns or villages, an electric or other light and power plant or system or extensions to or improvements of any existing electric or other light and power plant or system for public, domestic and commercial uses, and to provide for the cost thereof by the issuance of revenue bonds payable solely from revenues to be derived from the operation thereof, providing for an election on the question whether such bonds should be issued and authorizing the fixing and revision of rates to be charged for the services thereof."

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Board to Study St. Lawrence Project

At the request of President Roosevelt a planning board has been set up in Washington to prepare for inclusion under the public works program the St. Lawrence waterway project. Pressure has been brought to bear to speed up this project.

Those who constitute the board are: Gen. G. B. Pillsbury, representing the War Department; Nils A. Olson and T. Hultgren, Department of Agriculture; Thomas E. Lyons and Alfred Friendly, Department of Commerce; J. W. Carmalt, representing the Coordinator of Transportation; W. V. Hardie, Interstate Commerce Commission; E. P. Cotter, Shipping Board; Frank P. Walsh and Secretary Leland Olds, New York Power Authority; Chairman Frank R. McNinch, Vice-Chairman Basil Manly and Dr. Fayette S. Warner of the Federal Power Commission.

Chairman Walsh of the Power Authority of New York, in a statement issued last week, declared that "this is perhaps the greatest public works project undertaken since Theodore Roosevelt initiated the Panama Canal."

The President, according to Mr. Walsh, has made it clear that the simultaneous development of the St. Lawrence River for power and navigation is an essential part of the recovery program.

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Commissioners Discuss Regulation

Recovery program adds to regulatory problems.
Sentiment increases against federal regulation.
Uniformity in regulatory laws proposed.

GOVERNMENTAL activities aimed at getting us out of the depression are contributing in many ways toward making the problems of regulation by state commissions more complex. Thus during its annual convention at Cincinnati last week the National Association of Railroad and Utilities Commissioners found itself combating more than ever the federal tentacles menacing state regulation from several directions. But the exigencies of the times and the complexity of the problems left many of the members no choice but to recognize the inevitable necessity of some reliance on the federal regulatory arm. This was notably true of interstate motor transport, less so of depreciation accounting for telephone companies and still less so as to federal regulation of utility holding companies.

Donald Richberg, general counsel of NRA, made an eloquent plea for wholehearted support of that program, which he interpreted as an extension of the concept of utility regulation into general business, "really dreadful to contemplate, however, if carried into price and service regulation" by the meticulous procedure of the state commissions. Incidentally, he disclosed the reason for his high assignment in NRA was his 30 years of experience with utility regulation.

He frankly conceded that the price-raising objective would inevitably increase costs to the utilities as well as other industries, and of this the commissions would have to take due cognizance. But he did cite some negative factors: (1) Utilities suffered less during the depression, (2) some companies could absorb rising costs without endangering their fair return, (3) rising volume of business will dilate overheads and provide a margin for absorption of increased costs, (4) rising costs of competitive services might justify an improved revision of some wholesale rates and thus offset rising utility costs.

No action was taken on an appeal from the Brotherhood of Edison Employees that the association record its "belief in the duty and obligation of all state regulatory bodies to foster and support the aims and purposes of the recovery act." Nor was any action taken toward having the state commissions call upon the Tennessee Valley Authority for a reconciliation of the energy rates propounded by Authority Lilienthal with the available cost figures for the Muscle Shoals development and with the estimates of distribution costs made for the St. Lawrence project. Commissioner Morgan (Alabama) announced that he had advocated to his committee such an interchange of discussion, but the time had been too short to prosecute it before the convention met. Incidentally, news that Birmingham had rejected municipal ownership was manifestly pleasing to many of the commissioners.

An exhaustive report on the legal and accounting problems attending the alternative schemes of depreciation accounting was presented by John H. Bickley of the Wisconsin staff. Its principles agree with those enunciated by the Interstate Commerce Commission, most prominent among which is that straight line depreciation for ledger purposes cannot be different from the values set up to establish plant value for rate purposes. Commissioner Maltbie (New York) decried the assignment by Congress of I.C.C. jurisdiction over telephone depreciation and Commissioner

Elgen (D. C.) hopes that the federal board will ask Congress to remove the inequity and the injustice it had created by dividing responsibility over an essentially intractable function.

In the opposite direction went some of the sentiment expressed as to federal control of holding companies. Even though a resolution was passed providing a committee to draft a uniform bill calculated to promote the preservation of state jurisdiction by means of state-to-state uniformity, nevertheless there were many in favor of some federal board to elicit and disseminate facts of intercorporate relations not now facilely available to the state commissions. This view was held by Mr. Walker (Oklahoma). Attorney Rooks (Illinois) and Mr. Maltbie (New York) were strong for potent state legislation, although the former admitted the recent Illinois law was too drastic and detailed for practical administration of the regulation of the great mass of minor intercorporate transactions. Mr. Maltbie said it was futile to attempt to define control in terms of stock percentage—that control was demonstrably factual rather than mathematically ascertainable. Wide discretionary commission power instead of voluble legislation was his sole answer to the adroitness of the unscrupulous utility manipulator who keeps two jumps ahead of any law.

Considerable interest was again manifested in the matter of cost indexes as a means of obviating recurrent demands for valuation. Chairman West (Maryland) and Attorney Roberts (D. C. staff) pointed out that decisions were imminent in which the index procedure was being given a significant test of legal feasibility and acceptability.

During the past year the vicissitudes of politics had removed from the ranks of the association many of the matured commissioners. Four presidents had followed one another in succession during the year. An entirely new slate of officials had therefore to be elected, the presidency going unanimously to Richard T. Higgins, a stalwart survivor, since 1911 chairman of the Connecticut commission. Andrew R. McDonald (Wisconsin) and Frank P. Morgan (Alabama) were elected the two vice-presidents. Next year the commissioners will meet in Washington, D. C.

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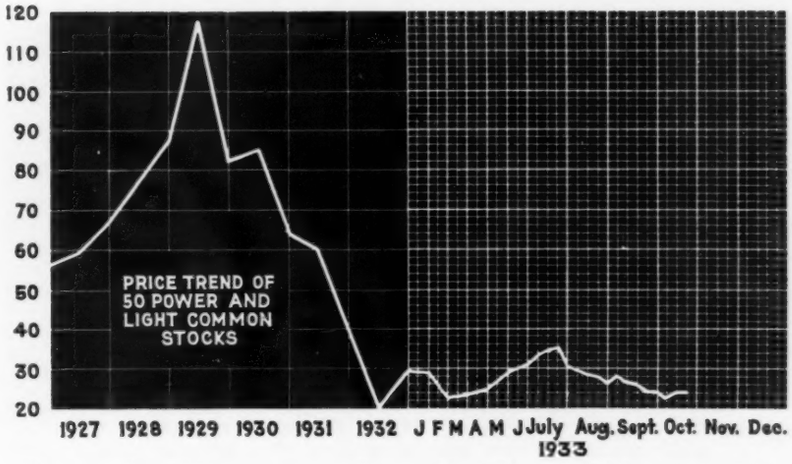
Boston Edison Pays Notes

The Edison Electric Illuminating Company on October 16 paid off its maturing $10,000,000 discount notes with the proceeds of loans arranged with the company's banks in Boston and New York. When these six months' notes were issued last April the company had in mind paying them off at maturity with the proceeds of a stock issue if conditions warranted, or, failing that, borrowing the funds from the banks.

Utility Stocks Yield Ground



In a market that was generally weak, utility securities lost some ground. After showing resistance, the "Electrical World" index receded this week to 23.7, compared with 24.4 last week.

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Relief Fund Taxes Levied on Utilities

Mayor O'Brien of New York signed last week the city bill placing a tax of 1½ per cent on the gross monthly income of public utility companies during the emergency for which the city must provide relief funds.

The bill, which became law with the Mayor's signature, was passed on September 15 by the Board of Estimate branch of the Municipal Assembly by fifteen affirmative votes. The Board of Aldermen subsequently passed it by a vote of fifty-two to one. The bill places a city tax on the gross income of every corporation, company, association, joint-stock association, co-partnership and person operating in the city subject to supervision of the Public Service Commission. The levy is effective from September 1, last, until February 28, 1934, and the proceeds are to go for relief and redemption of relief certificates already outstanding.

The new city tax must be paid at the end of every month, and is levied in addition to all other license fees and taxes provided by any other section of the law. At first public utilities thought they could obtain a rebate from the city on their special franchise fees, but the bill as explained by the Mayor rules out this possibility.

The bill expressly states that the revenue obtained from the imposition of this tax must be disposed of as follows:

"1. To defray the cost of granting unemployment home relief and work relief.

"2. To defray the cost of the interest of certificates of indebtedness issued in the first instance to obtain funds necessary to provide unemployment work relief and home relief, as well as to redeem such certificates of indebtedness now outstanding."

The penalty for failing to file a return or pay a tax is fixed at 5 per cent of the amount of the tax due plus 1 per cent of the tax for each month or fraction of a month of delay.

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Supreme Court Grants Seattle Utilities Review

Disposing of the petition of the Puget Sound Power & Light Company, the Seattle Gas Company and the Pacific Telephone & Telegraph Company, the U. S. Supreme Court last week ruled that probable jurisdiction was shown by these companies in their appeals from a lower court decision upholding an ordinance of the city of Seattle establishing a license for an occupational tax on business (ELECTRICAL WORLD, May 6, page 562). The validity of the tax, amounting to 3 per cent on the gross revenues, is attacked on the grounds that it is a license to do business. The power company contends it is licensed to operate in the state and has a franchise granted by the city of Seattle which does not expire until 1952.

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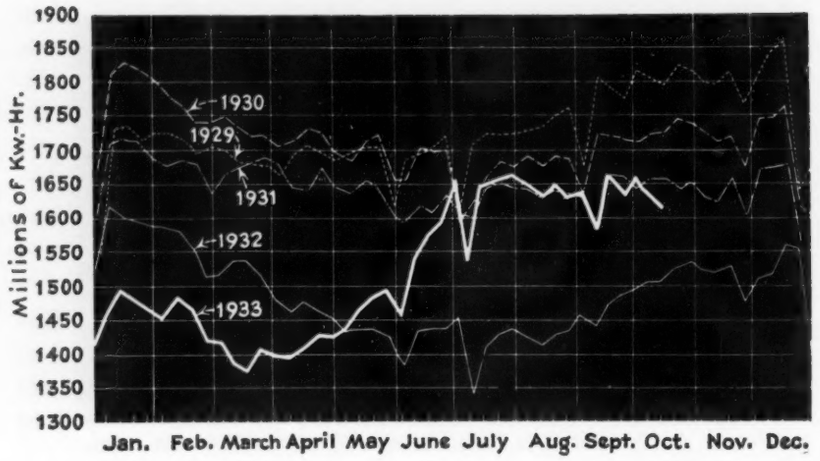
Columbia Dividend Cut

Directors of Columbia Gas & Electric Company have reduced the dividend on the corporation's common stock from 20 cents a share, declared last quarter in convertible preferred stock, to 12½ cents a share in the same medium. Regular dividends on preferred issues are being maintained.

Weekly Output Decreases



Effects of industrial disturbances, as lately reported from various localities, seem to be reflected in the output of central stations announced by the Edison Electric Institute for the week ended October 14. The total for the country, given as 1,618,948,000 kw.-hr., was 1.6 per cent less than in the preceding week, whereas the normal trend is moderately upward at this season.

As a result the gain over 1932 diminished to 7.4 per cent and the earlier week's slight deficiency compared with 1931 was materially increased. While a lead over 1932 was maintained in all regions but one the percentage were smaller except in the Middle Atlantic. Shrinkage was least in the Central and Mountain divisions.

Weekly Output, Millions of Kw.-Hr.

1933		1932		1931	
Oct. 14..	1,619	Oct. 15..	1,508	Oct. 17..	1,656
Oct. 7..	1,646	Oct 8.	1,506	Oct. 10..	1,653
Sept. 30..	1,653	Oct. 1	1,499	Oct. 3..	1,646
Sept. 23..	1,639	Sept. 24..	1,491	Sept. 26..	1,660
Sept. 16..	1,663	Sept. 17..	1,476	Sept. 19..	1,663

Per Cent Change from Previous Year

Region	Week ended Oct. 14	Oct. 7	Sept. 30
New England	+ 5.0	+ 8.4	+ 8.0
Middle Atlantic	+ 4.6	+ 4.5	+ 5.7
Central industrial	+ 9.9	+10.5	+12.7
West Central	— 0.0	+ 1.3	+ 3.0
Southern States	+ 8.2	+14.8	+15.8
Rocky Mountain	+22.1	+22.8	+29.4
Pacific Coast	+ 0.4	+ 2.7	+ 1.9
United States	+ 7.4	+ 9.3	+10.2

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Municipal P.W.A. Money Allotted to Danville, Va.

Danville, Va., was the first city to receive funds from the Public Works Administration for construction of a municipal electric plant. The extent to which the federal government will foster public ownership and operation is a matter of lively interest in view of President Roosevelt's emphatic support. The P.W.A. has still to invade territory occupied by a commercial company as Danville already is a public-ownership town.

With an allotment of $3,000,000, including an outright grant of $655,500, Danville will build a 10,000-kw. hydro-electric plant, with dam, tunnels and transmission lines, and repair its present steam plant for standby service.

A further list of allotments on October 13 includes a grant of $1,400,000 to San Francisco for construction of a 200,000-kw. hydro-electric plant in Tuolumne County and transmission and distribution systems in Alameda, San Mateo and San Francisco counties. The allotment represents 30 per cent of the cost of labor and materials on a project totaling $6,308,000. The balance will be furnished by the city and county of San Francisco if the voters approve the bond proposal covering this and several other projects at an election on November 7. The bonds will be offered in the open market.

A loan and grant of $200,000 was made to Brownsville, Tex., for rehabilitation of the municipal electric plant, water works, city hall and other structures damaged in the September 5 hurricane.

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Federal Trade Hearing on Insull and Peabody Coal

Intercorporate relations of the Peabody Coal Company and the Insull utilities were described at a hearing last week before the Federal Trade Commission, in its investigation of financing in the electric and gas utility field.

Testimony by W. B. Horne, commission examiner, indicated that 64.4 per cent of the Peabody stock was owned by Insull companies on July 1, 1932. In addition, 61.6 per cent of outstanding stock is held by a voting trust, with John F. Gilchrist and Stuyvesant Peabody as voting trustees. Samuel Insull was one of the original voting trustees, but he had resigned prior to July 1, 1932. At that time there were three classes of voting stock outstanding, as follows: 160,533 preferred; 198,867 "A" common; 1,781,518 "B" common.

Fourteen companies in the Insull group held Peabody stock, Mr. Horne testified, and in turn Peabody has control of eighteen companies, including coal, ice, land and other utility enter-

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New Reports on Light and Power Census Bring Total to Seventeen States

	Arizona		Idaho		Colorado		Vermont		Rhode Island	
	1932	1927	1932	1927	1932	1927	1932	1927	1932	1927
No. of reporting establishments	32	37	48	51	61	72	57	62	12	7
Commercial	28	29	32	37	33	36	41	48	11	6
Municipal	4	8	16	14	28	36	16	14	1	1
No. reporting distribution only	12	16	27	30	18	18	32	31	6	4
Prime movers, total hp	207,712	153,105	307,745	307,194	310,645	268,404	270,984	204,036	328,248	263,470
Steam turbines, hp	41,920	21,937	.....	2,000	194,094	173,579	15,525	15,008	325,456	258,685
Steam engines, hp	7,245	8,543	1,250	1,250	12,475	11,836	2,382	4,685	.....	2,500
Int. comb. engines, hp	31,782	17,115	3,158	1,105	13,584	4,050	.....	.....	450	.....
Hydro-turbines, hp	126,765	105,510	303,337	302,839	90,510	78,939	253,077	184,343	2,342	2,285
Generators, kw	133,308	100,600	208,007	208,117	221,246	198,919	188,808	141,420	243,285	194,700
Output, thous. kw.-hr	254,844	280,267	473,290	713,214	437,330	499,566	561,121	338,528	250,338	411,074

	New Hampshire		New York		South Carolina		Florida		Kentucky	
	1932	1927	1932	1927	1932	1927	1932	1927	1932	1927
No. of reporting establishments	36	42	122	177	43	58	41	60	28	42
Commercial	30	34	69	124	21	23	10	22	19	33
Municipal	6	8	53	53	22	35	31	38	9	9
No. reporting distribution only	18	21	69	79	27	30	9	10	8	8
Prime movers, total hp	420,911	157,331	6,276,029	4,212,355	939,956	700,433	534,575	359,437	455,367	395,238
Steam turbines, hp	80,179	53,289	4,620,676	2,671,363	193,874	148,763	457,820	299,266	302,241	244,215
Steam engines, hp	3,118	6,673	47,858	109,260	3,422	14,054	7,830	13,699	8,316	8,815
Int. comb. engines, hp	2,161	1,835	20,780	8,042	2,215	1,278	47,645	37,147	3,470	4,131
Hydro-turbines, hp	335,453	95,534	1,586,715	1,423,690	740,445	536,338	21,280	9,325	141,340	138,077
Generators, kw	283,321	115,554	4,577,641	3,157,615	642,856	491,208	363,052	293,242	339,771	298,039
Output, thous. kw.-hr	680,607	226,444	10,976,564	9,917,686	1,294,883	1,116,267	606,909	567,980	681,947	505,564

prises. Besides, it holds stock in seven other Insull utilities, he asserted.

Large proportion of coal mined by Peabody is sold to Insull utilities under long-term contracts. In addition, Peabody has management contracts to operate certain coal mines controlled by the Erie Railroad, Mr. Horne testified.

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Hearing Radio From the Stars

A New York City audience for the first time on Wednesday, October 18, heard radio waves that have been traveling through space for 40,000 years, coming from a fixed point in the Milky Way, that corresponds closely with the center of our galaxy of 30,000,000,000 stars. This cosmic radio was brought from the sensitive directive antenna of the Bell Laboratories station at Holmdel, N. J., and transmitted to the auditorium of the American Museum of Natural History, where a joint meeting of the Amateur Astronomers Association and New York Electrical Society was in progress.

Karl G. Jansky, discoverer of this "radio from the stars," interpreted his observations and measurements which accurately place the principal source as on the 18-hour Right Ascension meridian, at about 20 degrees south declination. He also revealed new evidence showing that the whole Milky Way region seems to radiate faint short-wave impulses which are received on his antenna whenever it is pointed at any part of the galaxy. This he interpreted to mean that stars which are sources of radio frequencies must be scattered all throughout the galaxy, pointing out that the maximum under these circumstances would seem to come from the center of gravity of the galaxy itself, as his observations also show.

Questioned about the enormous power of the cosmic energy sources which are able to lay down an audible radio signal here on earth, from distances so profound, Mr. Jansky pointed out that tremendous amounts of energy are available in the average star, and it would not be surprising if some of these stars radiated on frequencies falling within the spectrum we know as radio. Our own sun, for example, one of the smaller stars of the galaxy, is continuously radiating energy at the rate of 500 sextillions of horsepower (500,000,000,000,000,000,000,000 hp.) chiefly in the visible and adjoining frequencies. The sun's radiation contains none of the radio frequencies which Mr. Jansky detects coming from other stars in space. If it did transmit radio waves, owing to its nearness (90,000,000 miles) broadcasting on earth would be completely blasted by the interference. Possibly stars in the earlier stages of evolution are radiating these radio frequencies which he observes, suggested Mr. Jansky. Stars go through a series of evolutionary changes, along which our sun is now well advanced to "old age." Perhaps eons ago in its history the sun too was a radio transmitter, as are other stars in the galaxy at present, but now the sun is radiating on other ether frequencies and leaving our radio on earth fortunately unspoiled.

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Liquidation Committee for S.E.D.

At a meeting of the board of directors of the Society for Electrical Development held in New York on October 10 it was unanimously voted to dissolve the organization. The society has been operating with a skeleton organization for a year or more in the process of winding up its affairs. A liquidating committee was appointed under the chairmanship of B. F. Weadock.

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Lynchburg Dam Hearing Set

Hearing of the joint application of the Chesapeake & Ohio Railway Company and the Appalachian Electric Power Company for permission to release the Lynchburg dam across the James River and associated properties from any public obligation relating to the James River and Kanawha Canal has been set by the Virginia State Corporation Commission for October 30. The petitioners also ask permission to discontinue as a canal the Lynchburg level of the James River and Kanawha Canal and associated properties and to abandon their use as a public way.

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Treasury Outlaws Contact Men

According to an announcement by L. W. Robert, Jr., assistant secretary of the Treasury, that department will "look with much disfavor on those architects or engineers who retain legal counsel in Washington to aid them in securing professional contracts from the department; in fact, it will be the disposition of the department to eliminate such architects and engineers from consideration altogether. The department desires to make its selections on the merits of each case alone."

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Canadian Town to Sell Plant

Offer as been made by the town of Ste. Anne de Bellevue, in the province of Quebec, to sell its electrical plant to Montreal Light, Heat & Power Consolidated for $90,000, but this offer has been countered by the company with a bid of $50,000. The town's plant was constructed 19 years ago at an original cost of $130,000. Power has been received by the town from Montreal Light, Heat & Power under contract which expired on July 16. The company continues to supply electricity, which is retailed to consumers at 8 cents a kw.-hr. net.

Major New Construction This Week

Power substation equipment, motors and controls, regulators, electric hoists, conveyors, etc., will be purchased for new plant, nineteen buildings, of Standard Brands, Inc., New York, in Elmhurst district, Oakland, Calif., for malt and alcohol spirits manufacture. Bids asked in November. Cost $500,000.

Transformers and accessories, motors and controls, conveyors, etc., will be installed in multi-story addition to rayon mill of Courtaulds (Canada) Ltd., Cornwall, Ont. A $2,000,000 project.

Progress Brewing Company, Oklahoma City, Okla., approved plans for multi-story plant. Cost $500,000.

Until November 1, Bureau of Reclamation, Denver, Colo., asks bids for electric pumping machinery, with switchboard panel and accessories, for the Minidoka project, Idaho (Specification 602-D).

Danville, Va., has secured federal loan of $2,500,000 for construction of hydro-electric generating plant on Dan River, Patrick County, and transmission system to serve number of communities in vicinity. Bids scheduled at once.

Motors and controls, electric pumping machinery, transformers and other equipment will be installed in new oil refining plant of Alkot Petroleum Company, Chase, Kan., recently organized. Cost about $100,000.

Geysers Development Company, Los Angeles, Calif., plans purchase of two 1,000-kva. turbo-generators and complete accessory equipment, transformers, switchboard and auxiliary equipment for central station at Healdsburg, Calif., where commercial service will be furnished. Franchise secured. Also will install equipment for electrifying Healdsburg pumping station.

J. T. S. Brown's Sons Distillery Company, Bardstown, Ky., plans multi-unit distillery, with power plant. Cost over $200,000.

Until November 1, Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids for motor-generator set for Puget Sound Navy Yard, Wash. (Specification 7485).

Official Results of Maine Tax Plan

Final figures in the Maine vote on the proposal for a sales tax on electrical companies (ELECTRICAL WORLD, September 23, page 389) indicate that the measure was rejected 90,804 to 46,015.

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New York Metal Prices

	Oct. 10, 1933 Cents per Pound	Oct. 17, 1933 Cents per Pound
Copper, electrolytic	8.75	8.00
Lead, Am. S. & R. price	4.50	4.25
Antimony	6.75–7.00	6.875
Nickel ingot	35.00	35.00
Zinc, spot	5.12	5.12
Tin, Straits	48.25	46.50
Aluminum, 99 per cent	23.30	23.30

As to Rates——

• Public Service Electric & Gas Company at hearings last week in the electric rate case now before the New Jersey Board of Public Utility Commissioners cross-examined Dr. John Bauer, economist, expert for the petitioners for the rate reduction. Dr. Bauer had previously testified that the proper rate base founded on U. S. Department of Commerce indexes should be $180,000,000 instead of the $385,000,000 set by the commission engineers. George H. Blake, attorney for the company, brought out that the major elements which go into an electric property are not included in the general wholesale commodity price index used by Mr. Bauer in his appraisal. He showed to the witness a list of elements which go into an electric plant and asked him whether they were included in the general list. Replying that they did not appear specifically, Mr. Bauer admitted he had not used indexes which were directly applicable to the electrical industry. He explained he had approached the problem not from the standpoint of the reproduction cost of the company, but from the angle of the dollar's purchasing power. "I was endeavoring," Mr. Bauer said, to find out what was the general change in the purchasing power of the dollar. I applied to the actual money invested an index which represents today's purchasing power of the dollar, as compared with that at the time the money was invested. The problem, as I saw it, was to arrive at a rate base which would conserve to the investor in the property an equivalent amount to the investment actually made in terms of present-day dollars." Inability of the company to complete answers to questions submitted at the previous hearing caused postponement of the case to October 26.

• Northwestern Electric Company's rate case recently resumed before the public utilities commissioner of Oregon, with the company substantiating the figures shown in its inventory and appraisal filed with the commission last July and rebutting the testimony of the commissioner's witnesses which consumed three weeks of hearing during September.

• Northern States Power Company properties in St. Paul, Minn., have been revalued at $23,904,275 by Burns & McDonnell, Kansas City engineers, as compared with $26,131,439, the original estimate. In the supplemental report submitted to the St. Paul City Council the major reduction in value was made through the elimination of the item of going concern value, which amounted to more than $2,000,000, and reduction of the item of working capital by more than $90,000. The new report stated that the company now is earning $910,000 more in the electric department than is necessary for a 6 per cent return and $759,950 more than is necessary for a 7 per cent return.

• Edison Electric Illuminating Company of Boston has been ordered by the Massachusetts Department of Public Utilities to furnish the following information requested by certain petitioners: List of all unpaid bills of political committees for service furnished in 1931 and 1932; the amount invested by company to connect its generating station with the Eastern Massachusetts Electric Company, what the investment represents, expense of furnishing electricity over this connection, income from sale of electricity by reason of this connection from beginning to November 1, 1932, and what the $5,000 paid by the General Electric Company as shown on exhibit 99 represents.

• Union Gas & Electric Company's controversy with the city of Cincinnati is purely a rate fight and must remain so, regardless of any municipal ownership agitation, Mayor Russell Wilson declared recently.

• Carolina Power & Light Company's application for a rehearing of the rate case pending before the South Carolina Railroad Commission (ELECTRICAL WORLD, September 30, page 426) was denied last week by that body. The commission's order, signed by John N. Nance, chairman, called for rate slashes ranging from 22 to 30 per cent in the bills of approximately 13,872 customers in the Pee Dee section of South Carolina. The cuts total $228,311 annually.

• Northern Indiana Public Service Company has granted the city of Hobart a reduction in electric rates of approximately 11 per cent. Following long negotiations, an agreement was reached, which will be submitted to the Indiana Public Service Commission. The agreement provides that the City Council shall withdraw its petition now on file with the commission. The domestic rate varies from 10 cents down to 4 cents a kilowatt-hour and the commercial rate is from 10 cents down to 3 cents.

• Figures just made public by the Indiana Public Service Commission show that since March 8 the commission has issued more than 600 rate-reducing orders entailing revenue losses to utilities of $1,025,146 annually, and of this loss the electric utilities will suffer $918,300. Reductions in electric rates were ordered following various methods of investigations, but without any of the cases going into long rate discussions, the department reported. In numerous cases negotiations were carried on by cities and towns direct with the utilities and the commission called on later to confirm the agreements.

• Alabama Public Service Commission has announced that interest on consumers' deposits placed with light, gas and water utilities as a guarantee for payment for service must be credited on the December bills of customers under an amendment to the general rules governing utilities announced recently. The interest rate prescribed is not less than 6 per cent and is payable when the deposit has been placed with the utility for a period exceeding six months. The deposits are required by the utilities in varying amounts, depending upon the probable monthly consumption by the customer.

• Corporation Commission of Oklahoma finds delay in its general investigation into electric rates charged throughout this state by electrical utility companies operating there. The engineering staffs of the commission have been reduced because of uncertainty over validity of claims on a special $50,000 annual utility investigation fund from which Governor Murray has forbidden any expenditures this fiscal year. A test of the legality of claims by employees supposed to be paid from the fund now is pending before the State Supreme Court. Much of the audit of books of the Public Service Company of Oklahoma has been completed, most of the work being done prior to the arising of the question of legality of the utility investigation fund. However, the commission at present does not have the employees nor money to finish the audit and have engineering estimates of property conditions made. The same applies to the study of properties of the Oklahoma Gas & Electric Company.

• Public Service Company of Indiana operation cost estimates were attacked by Sherman Minton, public counselor with the Indiana Public Service Commission, at recent hearings. The commission has cited the utility to show cause why its rates should not be reduced. The citation was issued on petition of the counselor and the hearing resulted from failure of negotiations between utility officials and the counselor. One of the principal objections raised by Minton to the company's financial set-up as forecast for the next year was an item of $1,800,000 allowed for depreciation. He claimed this amount was nine times greater than any previous depreciation allowance. The company's side of the increased depreciation figure is that earnings during the last two years were not sufficient to build up an adequate depreciation during those years and the increased figure was made necessary. Another objection of the counselor was to the company's proposed allowance of $102,000 for amortization of old power plants which are not needed under the new power distribution system. Minton declared this was excessive and that the amortization should have begun some years ago. He also objected to the company's plan for paying the federal 3 per cent power tax. This item, amounting to more than $131,000, Minton contended, would be passed on to the consumer.

Municipal Items

MOBERLY, MO. — Application for a $175,000 grant and $525,000 loan for a municipal light plant has been opposed by the Missouri Power & Light Company, which serves the city, at hearings before the Missouri State Advisory Board of the Federal Public Works Administration. The company contends that it is furnishing adequate service at rates approved by the Missouri Public Service Commission and that there is no necessity for the proposed new plant. The city is willing to buy the company's distribution system, but not its generating plant.

GENESEO, ILL.—In a letter addressed to its customers, the Illinois Northern Utilities Company announced last week that it intends to maintain its equipment in Geneseo and to continue service in spite of a city ordinance to the effect that the company must vacate the street on or before December 11. The letter reads, in part: "It has been brought to the attention of the company that solicitors attempting to secure consumers for the output of the partically constructed municipal electric plant are circulating a report that our company intends to discontinue service on or before December 11, 1933. The report is based upon a recent ordinance of the City Council purporting to order the company to vacate the streets of the city on or before that date. The company has been advised that the ordinance referred to is void and proposes to resist any attempted enforcement thereof. The company takes this opportunity to assure its customers that it will continue to serve them until its legal rights have been fully determined. . . . In the opinion of its legal counsel, the company has the right to continue to render service to those of its customers who desire service to be continued, and each of its customers has the right to decide for himself whether he will continue with the company or change over to the municipal plant, if and when the municipal plant is capable of supplying such service. . . ."

BELLINGHAM, WASH.—At an election on December 2 the voters of Bellingham will decide on the issuance of $150,000 in utility bonds to finance a municipal power and light plant. The project calls for construction of a dam and power plant in the vicinity of Cemetery Hill on Whatcom Creek and repair and use of the present plant at the mouth of the creek, abandoned in 1927.

NORWALK, OHIO — Chase National Bank, trustee of all the franchises of Ohio Electric Power Company, was granted a review of a lower court decision upholding the city in its Council action directing Ohio Electric to remove its equipment from the streets of the city within 30 days. The company held a perpetual franchise to use the streets, Chase National contends.

HARRISBURG, ILL.—Voters last week decisively rejected a proposal for issuance of $400,000 of revenue certificates to finance a municipal electric light plant.

▼

Carrier Current for Load Control

An application of carrier-current equipment for load control purposes has been made in New Hampshire, in connection with two fully automatic hydro-electric stations operated by the Twin State Gas & Electric Company, known locally as the New Durham and Merrymeeting stations.

The output of the Merrymeeting station is supplied to the system over a 4,000-volt line through the New Durham station, where the connection to the main system is made. An operator living near the New Durham station has supervision over both, with suitable instruments at New Durham to indicate the load that is being carried by the Merrymeeting station. Starting and stopping of the latter is accomplished by closing or opening the oil circuit breaker in the New Durham-Merrymeeting line at New Durham.

A General Electric single-tube carrier-current signal transmitter was installed in the New Durham station and a double receiver with coupling capacitors at Merrymeeting. A coupling to one phase of the 4,000-volt line with ground return is being used.

The two elements of the double receiver operate on opposite half waves, and consequently their independent actions depend on the relative instantaneous polarity of the supply voltage to the transmitter and receiver. Permanent connection to the supply voltage (110 volts, 60 cycles) is made at the receiver, and a standard double-pole double-throw governor control switch is used to reverse the supply connection to the transmitter. Each element of the double receiver controls the operation of the motor-operated gate-limit control, one element to open the gate and the other to close it.

▼

$170,000,000 Water Plan Referendum

Following qualification of referendum petitions, Governor Rolph has called a special California election for December 19 on the Central Valley water project of California. The legislature had adopted a plan authorizing $170,000,000 revenue bonds (ELECTRICAL WORLD, August 5, page 165). The plan also sets up water and power authority similar to proposals three times voted down in the state.

▼

Mercury Detector Sensitive to 100,000,000 to 1 Dilution

Development of a detector which will act if there be but one part of mercury vapor in a hundred million parts of atmosphere has been announced. The most sensitive previous type of mercury detector would give warning of one part of mercury in thirty million parts of atmosphere, so that the new apparatus is three times more sensitive than the old. Also it is much faster, responding in a few seconds, whereas the previous detector operates only after some minutes have elapsed. Notable increased protection and reduced mercury losses in mercury vapor generating stations is the goal.

When in operation the new detector draws flue gases from the stack of a mercury boiler. The gases are given a preliminary treatment to remove stack impurities which would nullify the work of the detecting mechanism and are then passed through an ultra-violet radiation, or light beam, coming from a mercury light source and of a wave length known as the resonance radiation of the mercury atom. This radiation is directed from a quartz-sodium phototube, which, unlike the usual type of "electric eye," is supersensitive to a beam of this character. The mercury vapor is opaque to this light and casts a shadow, just as smoke is opaque to ordinary light and casts a shadow when in such light.

The weakening of the ultra-violet ray of light instantly causes a small change in an electric current inside the tube, which, amplified by other tubes, operates the circuits giving warning of the leak of mercury by means of a red light and a gong.

Combined in the same apparatus is the previous mercury detector, in which the mercury vapor sweeps rapidly across a sheet of paper coated with selenium sulphide. The yellow coating becomes perceptibly darker when the mercury vapor strikes it, and to make the process of detection fully automatic a light ray is directed upon the paper and reflected upon a phototube. The slightest darkening of the paper cuts off the amount of light falling upon the electric eye, thereby reduces the electric current flowing within the tube, and causes a relay to operate the warning signals. According to General Electric engineers the two methods of detection are designed to check each other, although the resonance radiation method will be the process normally depended upon because of its greater sensitivity and quicker operation.

Is There a Basis for a National Promotional Rate?

By S. BINGHAM HOOD
San Leandro, Calif.

THAT utilities are sailing close to the wind is manifest. The leeway or the hazard can be measured by the departure from ability to earn 10 per cent by way of fixed charges. Any increase in fixed charges or in taxes or a decrease in rates that will not result in immediate recovery of revenue by increased consumption may well spell disaster for some companies. Salvation for such companies will rest in adoption of a true inducement rate. Whether such a rate is possible on a national scale and what its approximate magnitude can be is primarily a matter of statistics.

The data published in ELECTRICAL WORLD, January 7, 1933, pages 30-31, are significant in this respect. They have been reworked here to show that a $5 per month "delivery charge" with a 1-cent rate is not at all impossible on the average and should serve as a "value of service" rate to bring cooking, water heating and even house heating on a 10,000 to 14,000 kw.-hr. scale.

The conclusions here are based on averages and must not be applied to individual utilities for the purpose of drawing any conclusion except that they may be found to be above or below the average, or close enough to the average so that the conclusions can be safely applied to them. Giving this factor due weight, the curves herewith can be used more or less as a "national yardstick" to determine if any rate is substantially an average rate and therefore not far from being correct.

Curve *B* is plotted from a simplified demand-energy rate based on national averaged costs, being $4 per month as the "delivery charge" plus 1 cent per kilowatt-hour for all energy. This applies to integrated system demands of the national average of 1.37 kw., which happens to be just about that of a domestic consumer making full use of electrification except that of space heating. It could therefore be used by any average utility as a true "inducement" rate far simpler and more acceptable to the consumer than any complicated multi-step type of rate.

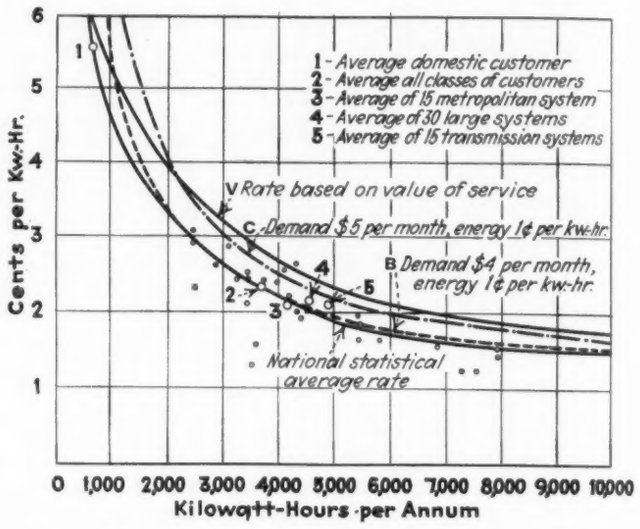
Delivery charge preferred to demand charge

The term "delivery charge" is here used as being far preferable to "demand," "readiness to serve," "service," or any of the more commonly used terms which react on the average consumer like a red rag to a bull. The public has become educated to purchasing on an f.o.b. factory or "cash-and-carry" basis and accepts the burden of arranging its own delivery. That factor should be used to advantage in selling electrical energy, particularly that for domestic application.

Since an applied rate that just returns the essential fixed charges on investment to serve existing average demand would not meet those charges with an increase in demand, and there will be some slight increase under a simplified form of true "inducement" rate, a higher base rate must be applied for safety. That rate is plotted as rate *C* and is a domestic rate of $5 per month delivery charge plus 1 cent for all energy. To those of our readers who may look upon 1-cent energy for domestic service as suicidal particular attention is drawn to the curve, which shows that of all the average and individual examples used to plot these curves only two utilities come above this basic rate curve, and they would quickly find their average rate lowered to below the line as a result of increase in domestic consumption.

Many other readers will say, "How can we adopt a rate that is higher than our present average rates in the face of an already popular demand for lower rates." The answer is that, eliminating those who are chronic kickers and would expect to be paid to use the service even if you gave it to them, most rates that are actually higher than the average, and truly above "value of service," are due to unintelligent allocation of costs.

Any rate, be it based on true cost of service or on false assumptions, will not get the business unless it is within the "value-of-service" range—that is, low enough


Cents per Kw-Hr.
6
5
4
3
2
1
1 - Average domestic customer
2 - Average all classes of customers
3 - Average of 15 metropolitan system
4 - Average of 30 large systems
5 - Average of 15 transmission systems
V Rate based on value of service
C Demand $5 per month, energy 1¢ per kw-hr.
B Demand $4 per month, energy 1¢ per kw-hr.
National statistical average rate
0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000
Kilowatt-Hours per Annum

A $5 and 1-cent rate has "value of service" attributes

Data from 30 individual large utilities were used (ELECTRICAL WORLD, January, 1933, page 30); two groups of fifteen each, one operating in metropolitan areas and the other serving large mixed areas over transmission networks. In plotting these curves the only definite points obtainable from national statistics were the domestic average shown at 1 and the average of all consumers shown at 2. From other statistics it was found that consumers having very large usage obtained their energy at between 1¼ and 1½ cents, thus establishing the level of the flat portion of the curve. In order to determine the shape of the curve the basic cost curve *(B)* was plotted. The actual operating cost was 1 cent per kilowatt-hour (exclusive of all fixed charges).

to enable the domestic consumer to do electrically those household chores which he can do by other means at equal cost. In order to determine what is the "value-of-service" limit curve *V* has been plotted. This is based upon actual results that have been, and are being, obtained by many utilities, and are as follows:

Graduate rates down toward one cent

The domestic consumer will pay 50 cents per month as a "delivery" charge to make electric service available in his home. He will also pay about 5 cents per kw.-hr. additional for up to about 50 kw.-hr. per month for use in lighting and operating miscellaneous appliances. His next most-desired application is that of the electric refrigerator, which will increase his consumption by about 45 kw.-hr. per month. For these he will most cheerfully pay 4 cents per kilowatt-hour. Having gone that far he is ready to install the electric range if he can get the 125 kw.-hr. per month it requires for about 2½ cents. Having his range, he can see no reason why he should use gas or other fuel to heat his water. If he can buy the extra 300 kw.-hr. per month that device requires for about 1 cent per unit he is ready to put in the water heater with his range. Having gone that far he can see no reason, except as to cost, why he should not use the ideal space-heating system—electricity, applied directly to the exact point where and when needed—no intervening losses, no health-damaging gases, no dust or ashes and no labor. You have him already sold, before you start, if you are willing to let him have another 8,000 kw.-hr. spread over the heating season at 1 cent per unit.

The range makes the next logical load

It will be argued that of the 20,000,000 existing live domestic prospects only about 5 per cent have ranges installed, and that it is only these few who would accept the new form of delivery charge plus energy rate. The answer is simple—hold the existing domestic rate for low consumption and use the true inducement form of rate to combat demands for lower existing rates. Educate consumers to the fact that the utility stands ready to lower his rate as fast as he, as an individual and not as a class, justifies such decrease by giving it all his business rather than splitting it up with the ice man, the gas man and the coal man. By using those tactics rate reductions that cut down on the top step can be forestalled and thus make it impossible to grant a rate that will come within the "value-of-service" limits for all the domestic business that is now beyond reach.

The various curves seem to indicate that most of the existing domestic load is being carried at a loss. It must be remembered, however, that our cost curves are based upon the national average demand of 1.37 kw., while the average domestic demand today is far less than that. Making allowance for this lower allocation of investment costs, it will be found that the actual loss is perhaps not as great as it is generally assumed to be. In the curve range between the existing domestic average of 600 kw.-hr. and the 2,500-kw.-hr. point, where curve is checked against actual spotting, we have an unexplored zone plotted by "guess." This is of no particular consequence since there is no visible domestic growth in this zone; the average domestic consumer jumps this entire zone in one bound when he installs the electric range, and that is the existing appliance that can be offered to fill this gap.

Getting $60 per kilowatt from domestic users

Touching briefly on the effect of a true inducement rate based on both cost of service and value of service and its effect on integrated system demand per domestic consumer:

The existing average investment, as of 1930, is $480 per consumer. This can be taken safely as applying to domestic load since the average is made up of 20,000,000 domestic out of 24,000,000 consumers. Of the 4,000,000 non-domestic consumers many are closely comparable as to investment cost to the domestic class, these being small stores or power users. The relatively few large commercial and power consumers clearly represent a far higher investment per consumer. It is self-evident, therefore, that in taking $480 as an average investment per domestic consumer we are "playing safe." Of that value at least $100 is allocable to factors of a strictly consumer type and not variable as to demand. Deducting that leaves the actual demand increment $380 per consumer with an average demand factor of 1.37 kw., or $275 per kw. In turn, a considerable proportion of this demand investment represents factors allocable to area covered

1931 Cost Data for 30 Representative Utilities

National average investment per customer for 1931 was $510. This is abnormal owing to shrinkage in number of customers with a fixed investment. The average investment per customer for 1930 of $480 may be taken as more representative when progress of economic reconstruction restores former business.

Identification	Kw.-Hr. per Customer	Revenue per Kw.-Hr. Cents	Operating Exp. per Kw.-Hr. Cents	Plant Value per Kw., Dollars	Kw. per Customer
Transmission Group					
1	3,520	1.33	0.45	358	1.10
2	7,970	1.54	0.67	288	2.22
3	7,600	1.25	0.59	256	2.00
4	3,740	2.42	1.20	400	1.43
5	6,830	1.58	0.87	409	2.41
6	5,100	2.33	1.14	375	1.64
7	7,980	1.46	0.70	375	1.88
8	4,170	2.24	1.14	442	1.16
9	4,255	2.62	1.51	387	1.52
10	4,180	2.21	1.41	327	1.15
11	3,390	2.51	1.21	548	1.05
12	4,000	2.43	1.25	450	2.11
13	5,470	1.89	0.99	315	3.38
14	2,895	2.65	1.15	546	1.05
15	3,070	2.90	1.29	311	2.81
Group average	4,944	2.09	1.04	386	1.79
Metropolitan Group					
1	4,375	2.00	1.29	234	1.44
2	2,460	3.11	2.06	228	1.42
3	5,870	1.68	0.74	304	2.28
4	2,485	2.94	1.67	445	0.89
5	4,520	2.04	0.84	385	1.43
6	4,340	1.95	1.00	267	1.57
7	3,465	2.13	0.95	249	1.39
8	4,075	2.61	1.35	388	1.76
9	5,420	1.64	0.75	261	1.81
10	2,510	2.36	1.34	205	1.05
11	5,400	2.14	1.98	324	1.47
12	3,440	2.45	1.03	249	1.61
13	3,670	1.54	0.60	320	1.71
14	3,260	2.45	1.12	341	1.22
15	7,320	1.25	0.69	520	1.32
Group average	4,174	2.14	1.09	315	1.49
Average of both groups	4,559	2.12	1.07	350	1.64
National (1931) average	3,750	2.32	1.00	370	1.37

rather than to demand. Giving fair weighted values to the above would indicate that system capacity can be increased to serve existing consumers in existing areas, by the average utility, at not to exceed $200 per kw.

Let us assume that a true inducement rate increases the present average demand of a consumer using lights, miscellaneous appliances, refrigerator, range and water heater, now at 1.4 kw., to 2 kw. On that basis the consumer investment would be $605 and our fixed charge return under rate *C* $60 per annum, or approximately the essential 10 per cent. The gross return per consumer on a 6,000-kw.-hr. basis would be $120, or $60 per kilowatt as compared to the existing average of about $58.

Space heating not to be ignored

Approaching Utopia, let us enter the zone of space heating, with its possible energy consumption more than equal the grand domestic total already in sight. Such heating will impose some added capacity requirements. How much we do not know. The electric range was once frowned on owing to its high demand. With more experience we found it necessary to place a decimal point ahead of its nameplate rating to get the true system demand. The same, with perhaps somewhat lower diversity, will unquestionably be found with space heating.

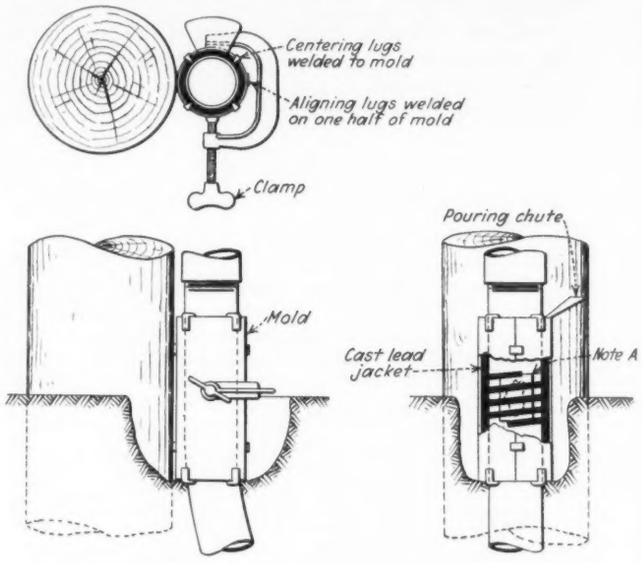
With proper and reasonable economic sequence control installed as part of the consumer's equipment it is my belief that space heating can be added to the domestic load without materially increasing the capacity allocation above 2 kw. Let us, however, play safe and discount our guess, based on close study of existing data, by 50 per cent, making the allocated system demand per domestic consumer, fully electrified, 3 kw. That would increase the investment from $605 to $805 and the gross return on a 14,000-kw.-hr. annual basis to $200, or an average return of $67 per kw., as compared to the present unsatisfactory average of $58. The return from the "delivery charge" element of the rate would be $60, or only 7½ per cent, and inadequate.

However, with homes using 14,000 kw.-hr. the energy cost will not be 1 cent. Our assumed 1-cent operating cost covers not only cost of generation but also all and every cost not strictly allocable to fixed charges. It is a well-accepted fact that actual energy cost averages in large plants 5 mills or less. Our national statistics show that for the three years prior to the 1929 crash the increased energy output was obtained at an increased operating cost of 0.75 cent per kilowatt-hour. If we did that for three years running we can keep on doing it. Assume that of the 14,000 kw.-hr. domestic consumption 4,000 is supplied under existing average conditions, leaving 10,000 to be supplied at the 0.75-cent operating cost we know from past experience to be a safe value. That leaves $25 per annum transferable to our fixed charge increment, raising it to $85, or 10½ per cent on our investment and moving us back onto "easy street."

If our assumptions are sound, then all we need do to get started on our trip to Utopia is to start. We need not waste time sitting around the table and discussing route maps over roads projected but not built. Get started—use an existing road where available and seemingly leading in the right direction; if not, build our road as we progress. The Oregon trail wasn't paved back in '49, but our forefathers got there just the same. We can get there too if we tune up the old flivver and buy a cheap trailer to hitch on behind to carry the excess load.

Protecting Riser Pipes from Ground Line Corrosion

Details of the New England Power Association's standard method of protecting new or existing riser pipes from ground-line corrosion are shown. Protection is obtained by pouring a lead jacket around the surface of the pipe after all scale has been removed. The purchasing department of the association at Boston, Mass., furnishes molds to subsidiaries on requisition for 2-in., 3-in., 3½-in. and 4-in. riser pipe.



A—Cover all corroded holes in riser pipe with a thin metal sheet, held in position by several wraps of friction tape.

B—Locate mold so that lead jacket will extend equally above and below corroded area.

C—When necessary, set mold on bed of dry sand to prevent molten lead from running out at bottom.

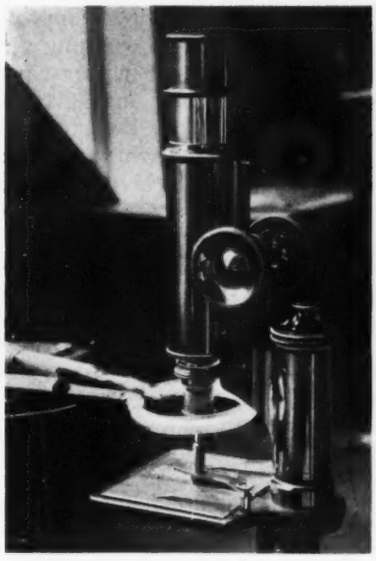
D—Reclaimed lead from scrap cable may be used to make the protective jacket.

E—After lead jacket is cast remove mold. Calk jacket and paint with P. B. paint.

Indirect Portable Lamp Sales in Chicago

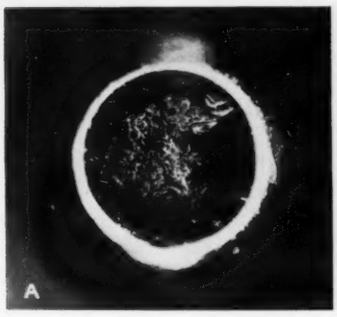
An activity which produced a considerable increase in lighting load to residential customers was the sale of indirect portable lamps. These lamps were carried on appliance-sales trucks and sold by a house-to-house canvass by straight commission salesmen working from the trucks. An unusually good acceptance was found for this equipment. Most of the sales were made on a first call, but when the customer asked to have the lamp left overnight for a trial this was done. These lamps were equipped with one 300-watt and three 60-watt lamps and provided with a silk shade. They sold for $14.95 each. During the fall months sales were at the rate of about 3,000 per month.

M. W. ROSS,
Commonwealth Edison Company,
to 1933 convention of Illuminating Engineering Society.



Microscope for inspection of meter jewels and pivots

The circular gaseous lighting tube insures an even intensity of light on the surface of the observed object.



Point and side of a defective pivot

Microscopic Inspection Aids Study of Meter Jewels

By L. H. KISTLER*

Northwestern Electric Company, Portland, Ore.

In an effort to improve the technique of the routine inspection of meter jewels and pivots the Northwestern Electric Company has been experimenting with the microscope as a means of detecting flaws and irregularities. Because of the fact that the points of needles ordinarily used in exploring the surface of jewels become damaged after a very few tests, it is difficult to locate defects in the jewel accurately and the microscopic method of inspection has proved a far more satisfactory method.

In conducting the routine jewel and pivot inspection the jewels and pivot are removed from the meter in the field after the "as found" readings have been taken. The meter tester replaces them with new jewels and pivots or ones which have already passed the microscopic inspection. Each tester carries a container for both good jewels and pivots and those removed from service. When a sufficient supply has been accumulated the jewels are dressed off on a screw head with emery cloth so that they will rest flat on the microscope. Then they are cleaned in a spray of carbon tetrachloride, which evaporates rapidly and removes all traces of oil or dust. Other means of cleaning usually leave foreign particles on the surface of the jewel.

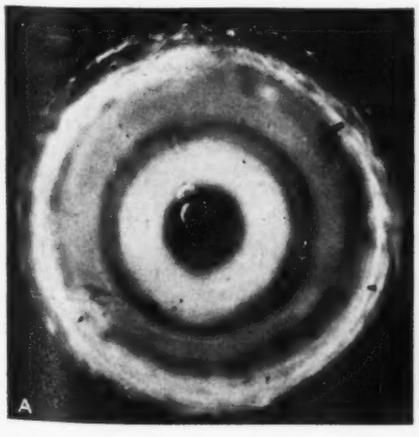
To obtain an even illumination of the surface of the jewel under the microscope presented some difficulty, which was finally solved by using a white neon tube looped around and just above the jewel, as shown in the accompanying illustration. This eliminated reflection, glare and uneven light on the surface of the jewel.

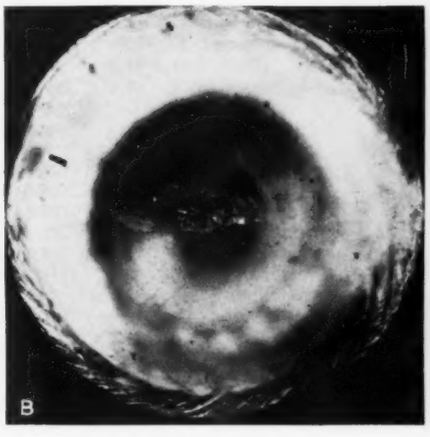
The microscopic method of inspection is more accurate than the needle method and involves practically no more time and labor. Six classifications are used in reporting on defective jewels, namely, overloads, circular abrasion, slight, medium and large cracks and rough surface.

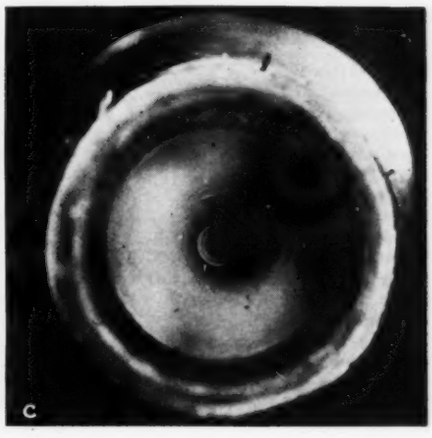
From a paper presented at the Engineering Section meeting, Northwestern Electric Light and Power Association, Portland, Ore.

How three jewels appeared under the microscope

In taking these photographs a red neon light and panchromatic film were used. (A) Jewel from meter that has been subjected to heavy overloads. The pivot tends to climb up the side of the jewel cup, always in the same direction. (B) Jewel that has been cracked in service. (C) A good jewel except for minor defects.







Progress Continues in Industrial Activity

After a moderate recession in August the general level of industrial activity, measured by energy consumption in manufacturing establishments, as reported to ELECTRICAL WORLD, rose 4 per cent in September. While the maximum for the present period of recovery, registered in July, was not quite attained it was closely approached, the difference between the figures for the two months being only 2 per cent. The computed index exceeded that for September of last year by 31 per cent and of 1931 by 10 per cent. In returning to the figure for 1930 it indicates a recovery of the ground lost in the intervening three years.

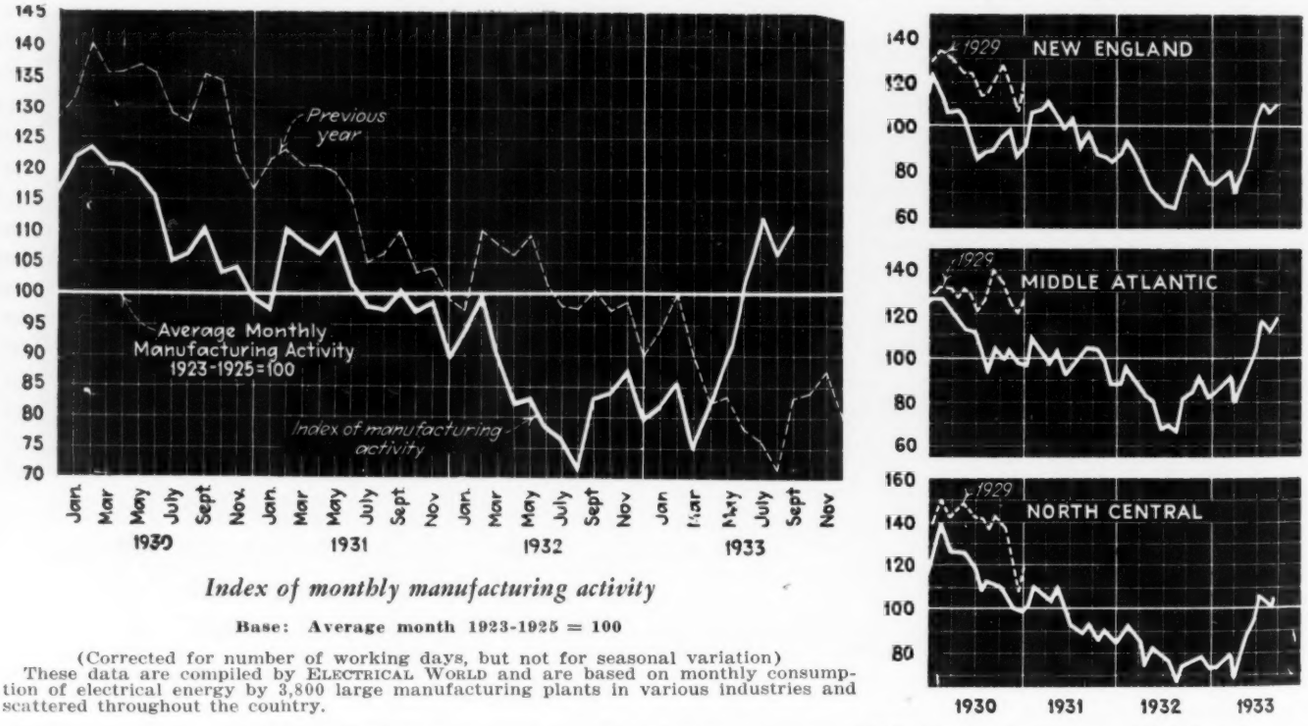
In these comparisons adjustments have been made for the fact that August, with 31 calendar days, had only four Sundays, while September, with 30 days, included a holiday in addition. The unadjusted figures would show a slightly smaller total of production in the shorter month.

The outstanding feature brought out by the accompanying tables is the almost unexceptional improvement compared with operations a year ago, running up to 78 per cent in iron and steel, 31 per cent in forest products and 18 per cent in the stone, clay and glass group. These are, in the main, capital goods industries. Partly in this class, also, is metal working, which embraces the manufacture of machinery and which has risen 59 per cent.

In what has been called the consumer capital group the automobile industry continues far above the 1932 level, the gain for September being 69 per cent, notwithstanding the disturbances reflected in the month's returns by general recessions from those for August—several of them much too severe to be accounted for by the mere difference of two working days.

In contrast are the generally more moderate gains in the distinctly consumer group, notably food products, which are admittedly more "depression-proof" and which have never fallen so low as the capital goods industries. Even in that group, however, activity in textiles is 28 per cent higher than a year ago, though off 9 per cent from July.

Regional changes were similar to those for the country as a whole, though local variations appear.



Index of monthly manufacturing activity

Base: Average month 1923-1925 = 100

(Corrected for number of working days, but not for seasonal variation)

These data are compiled by ELECTRICAL WORLD and are based on monthly consumption of electrical energy by 3,800 large manufacturing plants in various industries and scattered throughout the country.

	United States				New England				Middle Atlantic				North Central			
	Sept.,	Aug.,	July,	Sept.,	Sept.,	Aug.,	July,	Sept.,	Sept.,	Aug.,	July,	Sept.,	Sept.,	Aug.,	July,	Sept.,
Industrial Groups	1933	1933	1933	1932	1933	1933	1933	1932	1933	1933	1933	1932	1933	1933	1933	1932
All Industry	**110.3**	**106.2***	**112.9***	**84.6**	**109.6**	**108.1***	**110.1**	**80.5**	**120.0**	**114.4***	**119.3***	**83.8**	**104.5**	**101.5***	**107.8**	**74.8**
Automobiles (including parts and accessories)	61.8	63.7*	66.6	36.5	....	....	....	....	71.0	63.5*	68.7	40.2	60.8	63.8*	66.1	36.5
Chemical products (including oil refining)	166.7	152.5*	152.0*	126.8	188.5	153.0*	160.7	136.3	175.0	163.0*	162.6	132.1	150.3	144.4*	145.5	107.8
Food products	138.5	133.3*	149.8	129.5	....	....	....	....	153.9	143.0*	156.0	114.9	134.4	132.0	149.1	129.0
Iron and steel	90.2	88.3*	95.0	50.6	149.0	153.2*	159.7	91.3	78.0	73.2	79.2	40.0	95.6	95.2*	102.8	53.2
Metal working	82.0	76.4*	79.6	51.8	115.6	108.8*	107.1	68.7	71.2	66.3*	68.5*	50.2	84.0	78.4	84.5	46.1
Metals group	85.2	80.7*	85.3	51.3	125.0	121.4*	121.8	75.0	74.3	69.4*	73.2*	45.8	88.4	84.8*	91.5	48.6
Leather products	96.0	101.2*	102.7	93.7	86.7	89.2	96.0	94.2	111.2	123.2	116.5	108.2	85.0	85.0	89.7	76.7
Forest products	105.7	99.7*	102.0	80.6	61.0	60.3*	53.6	42.0	67.7	63.2*	72.0	45.4	101.8	101.0*	103.3	85.6
Paper and pulp	142.0	130.0*	130.2	107.0	151.2	135.4*	128.5	110.5	117.0	108.5*	106.8	68.7	138.8	123.0	121.0	103.7
Rubber products	132.0	143.5	157.0	87.7	134.8	141.7*	136.8	96.8	....	....	....	....	126.8	140.0	159.7	83.3
Shipbuilding	83.5	80.0	75.7	84.0	....	....	....	....	....	....	....	....	....	....	....	....
Stone, clay and glass	106.3	105.1*	113.5	90.3	....	....	....	....	85.0	92.8*	100.7	70.6	122.3	127.6*	131.5	109.3
Textiles	110.8	110.3*	121.3	86.7	82.7	85.8*	90.5	67.5	156.5	151.2*	160.6	111.0	139.2	126.5*	122.3	104.2

*Revision.

Ventilation of Transformer Manholes and Vaults

By W. T. ROSE
Chicago, Ill.

PROVISIONS for ventilation of manholes and vaults in which transformers are installed are frequently matters of routine design based upon judgment that may not always prove to have been good or upon empiric formulas that sometimes do not give the best results. In order that ventilation design of these spaces shall rest upon a firmer foundation than just some one's guess, the accompanying chart is used by the Commonwealth Edison Company in the layout of its 4-kv. transformer manholes.

At full load approximately 1.7 per cent of the transformer kva. rating is loss and is given off in the form of heat. This heat is conducted away from the vaults and manholes in two ways—first, through the walls, and second, by ventilation. Manhole and vault walls will conduct a large amount of heat away. The amount is controlled by four factors, the wall material, the thickness of the wall, the area of the wall surface, and the difference in temperature between the two faces of the wall.

Concrete has a conductivity of 8.3 B.t.u. and brick has a conductivity of 5.0 B.t.u. through a wall 1 ft. square, 1 in. thick and with a difference of 1 deg. F. between wall faces in one hour. The total amount of heat transmitted through a wall varies directly as the time, the wall area and the difference in temperatures between wall faces and inversely as the thickness of the wall. This may be expressed by the formula:

$$\text{B.t.u. per hour} = \frac{C A_w D_w}{Z} \qquad (1)$$

C = Conductivity of wall material.
A_w = Wall area in square feet (including floor and roof).
D_w = Temperature difference between inside and outside wall surfaces.
Z = Wall thickness in inches. For manholes add 6 in. to Z to compensate for the insulating effect of the earth adjacent to outer surface of wall.

To conduct away the remaining heat that the walls cannot dissipate ventilation must be used. In most cases natural draft is sufficient, because the wall area of the manhole or vault is usually large enough to take away a large percentage of the heat. The amount of air circulated by natural draft is controlled by three things—the difference between the air temperature inside the vault and outside the vault, the difference in height between the intake and the exhaust and the area of the ventilator opening.

The velocity of the air through the ventilator opening may be calculated by the formula:

$$V = \sqrt{\left(\frac{T_1 - T_2}{T_2}\right)(2GH)} \qquad (2)$$

T_1 = Absolute temperature F. in the vault.
T_2 = Absolute temperature F. outside the vault.
G = 32.2 (acceleration of gravity).
H = Head, difference in height between intake and exhaust.
V = Velocity of air in feet per second.

The amount of heat conducted away by the air may be calculated by using the following formula:

$$\text{B.t.u. per hour} = AVSD_a\,(3{,}600) \qquad (3)$$

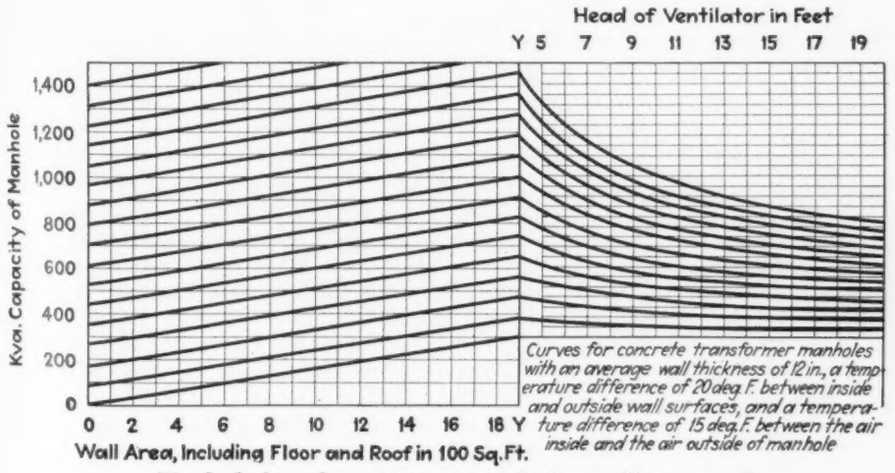
A = Area of ventilator opening in square feet.
S = Specific heat of air = 0.018. This is the B.t.u. required to raise the temperature of 1 cu.ft. of air 1 deg. F.
D_a = Difference between the air temperature inside and outside the vault, deg. F.

Since it is necessary to have the size of the ventilator opening in the design of a manhole or vault, equation (3) may be placed in the more convenient form:

$$A = \frac{\text{B.t.u. per hour}}{VD_a\,(64.8)} \qquad (4)$$

The B.t.u. per hour in equation (4) is the difference between the transformer heat loss in B.t.u. per hour and the heat conducted away by the walls.

B.t.u. per hour = (0.017) (kva.) (3,415) — B.t.u. per hour from equation (1). (5)
Kva. = Total transformer capacity.
One kw. = 3,415 B.t.u. per hour.


Head of Ventilator in Feet
Y 5 7 9 11 13 15 17 19
Kva. Capacity of Manhole
1,400
1,200
1,000
800
600
400
200
0
0 2 4 6 8 10 12 14 16 18 Y
Wall Area, Including Floor and Roof in 100 Sq.Ft.
Cross-Sectional Area of Ventilator in Sq.Ft.
25
20
15
10
5
0
Curves for concrete transformer manholes with an average wall thickness of 12 in., a temperature difference of 20 deg. F. between inside and outside wall surfaces, and a temperature difference of 15 deg. F. between the air inside and the air outside of manhole

To find size of transformer manhole ventilator opening

The area of the ventilator opening for a concrete manhole with an average wall thickness of 12 in. can be obtained from the curves of this chart. These curves are drawn for a difference in temperature between wall surfaces of 20 deg. F. and with a difference of 15 deg. between the outside and inside air temperatures. To find the ventilator area for a manhole start at a point corresponding to the total "wall area." Move this point vertically until it is horizontally opposite the "kva. capacity of the manhole." Now follow the inclined lines toward the right until the vertical line *Y-Y* is reached, then continue to follow the path of the curves until the point comes vertically below the "head of the ventilator" for the manhole. The "area of the ventilator" can then be found by projecting a horizontal line from this point to the scale on the right-hand side.

Therefore from equations (4) and (5)

$$A = \frac{(58.06)\ (\text{kva.}) - (CA_w\ D_w) \div Z}{VD_a\ (64.8)} \qquad (6)$$

or

$$A = \frac{(58.06\ (\text{kva.})\ Z - CA_wD_w}{ZVD_a\ (64.8)} \qquad (7)$$

If the ventilator opening has any obstructions, such as grates or louvres, allowance should be made so that the net open area is equal to A.

It is not worth while to plot curves, as in the accompanying chart, for transformer vaults because the outside wall temperature depends upon the vault location. In some cases the outside and inside wall surfaces will have the same temperature and all of the heat must be carried away by ventilation, thus reducing equation (6) to

$$A = \frac{(58.06)\ (\text{kva.})}{VD_a\ (64.8)}$$

▼

Possible Economies in Low-Head Plants

Specific suggestions for working out economical designs of hydro plants have just recently been made available by one of the former N.E.L.A. committees through the E.E.I. report A 18. Referring to low-head plants the reporting committee says in part:

"Deep intakes, especially those with relatively small pondage draft, seldom require curtain walls due to the ease with which ice and trash can be handled by a sluice above the rack structure. A skimmer wall outside the forebay proper, parallel to the river flow, has proved beneficial in certain situations. Special structures for stop logs for unwatering racks are many times unwarranted in shallow intakes, as the guides for mechanical rack-rakes can frequently be adapted to accommodate stop logs. The increase in size of waterwheels and successful use of mechanical raking devices have permitted higher water velocities through racks and consequent savings in these structures. Bar spacing of 6 in. is not uncommon. Compressed-air clearing has been widely and successfully used. In some plants all underwater beams and supports have been stream-lined to reduce losses. Welded rack construction decreases rack losses and cost of construction. Provision for cleaning racks in very deep reservoirs is now considered unnecessary. A unique method of keeping racks clear of wood-pulp waste was used at Shawinigan Falls. The racks, which are inclined, consist of a double set of bars, one set advancing and retreating past the other set, thereby bringing the trash to the surface.

"Water passages behind the racks must be of smaller area to reduce first cost and this can be done by increasing the water velocity, without objectional losses if a bell-month intake serves as the transition.

"Equipment for control of water is so dependable today under all flow conditions that the velocity at the gate can be increased nearly equal to that at the casing entrance. When a plant contains more than two units, economy generally dictates the use of a single set of gates with a transfer device so that they may be used in any unit. This automatically eliminates a valve as intake control for plants having more than two units. Intakes with two or more gates per unit can take advantage of the decreased cost of sliding gates by installing only one self-closing gate in combination with the sliding gates. For emergency shut-down with full-load flow the sliding gates must close with a differential head equal to the velocity head of the full-load discharge through the single self-closing gate.

"Often the velocity of the water in the scroll case can be increased without loss of efficiency in the unit, resulting in a saving in space and first cost. Use of plate-steel scroll cases have several advantages, one of which is to lower the cost due to elimination of intricate forms and placing of reinforcing necessary with concrete cases. As the size of units increases, however, the economy is doubtful. Provision for continuous water-measuring devices may be made at the time of construction at practically no additional cost, and experience shows that at some time they may be very useful.

"The high-speed runners developed for low head with attendant decrease in cost of power house and equipment places increased importance on the efficiency of draft tubes. It appears," says the committee, "that steel-plate forms for both the elbow and concentric type tend toward economy. The high cone in concentric tubes results in increased cost with doubtful economy. Large low-head units require draft-tube stop logs for unwatering for repairs. Steel sliding gates in one or more sections with a transfer device have been used with economy."

The report also covers high-head plants and hydraulic structures outside the power house.

▼

Adjusting Dispatching Department to Code

The Central Maine Power Company, realizing for some time that something similar to the NRA would be effective, early began to plan to adapt its load-dispatching department to changed conditions. Increased elasticity and provision for enlargement of the staff were features of major importance in connection with the change from a 56-hour week to a 40-hour week. The acceptance of the NRA Code by the company makes it necessary to complete the change by March 1, 1934, and it is expected that the necessary training of operators will be completed well before that date.

Part of the plan of forming an elastic department consisted in establishing a sub-dispatching department as a training ground for dispatchers to handle certain areas of the generating system under the immediate supervision of the main dispatching department at Augusta. In addition, special assignments are to be given to others in the organization located at the larger power stations on the system to help them easily to adapt themselves to fit in as load dispatchers.

Whenever it has appeared necessary to change the locations or modify the number of employees in this portion of the company the policy has always been to keep a skeleton dispatching department in the background ready and available for service at a moment's notice. The company states that the idea that any sys-

tem dependent almost wholly on hydro-electric generation can change a highly trained dispatching department almost overnight from a 56-hour week to a 40-hour week without experiencing some difficulty is not giving due credit to the nature of a dispatcher's job. To quote:

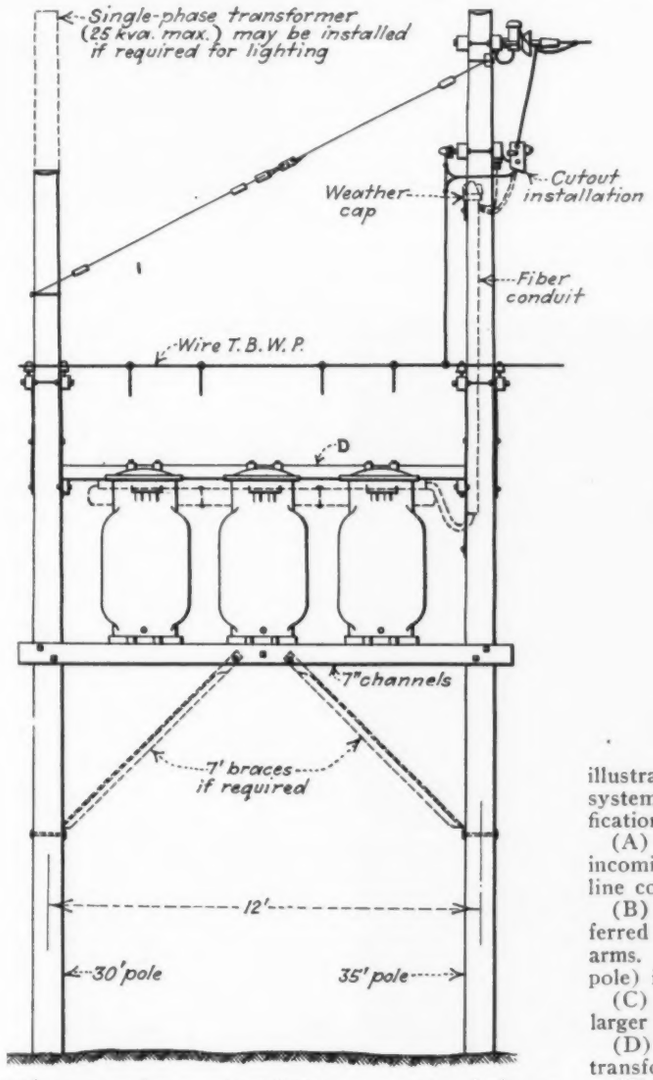
Such a change takes time, training and experience. The department is one of the most important units in the operating group and the personnel must be highly trained in their particular line of work before it can be done efficiently. They must be competent operators and intimately familiar with every detail in the transmission network before they can be trusted to issue orders involving the cutting in and out of lines. They must carry the respect and confidence of the personnel with whom they come in contact, especially linemen and station maintenance men, because a mistake on the part of the dispatcher might mean loss of life where men are at work on lines or apparatus. For scheduling plant operation they must have the background of long experience and become familiar with what we call the "habit" of the rivers.

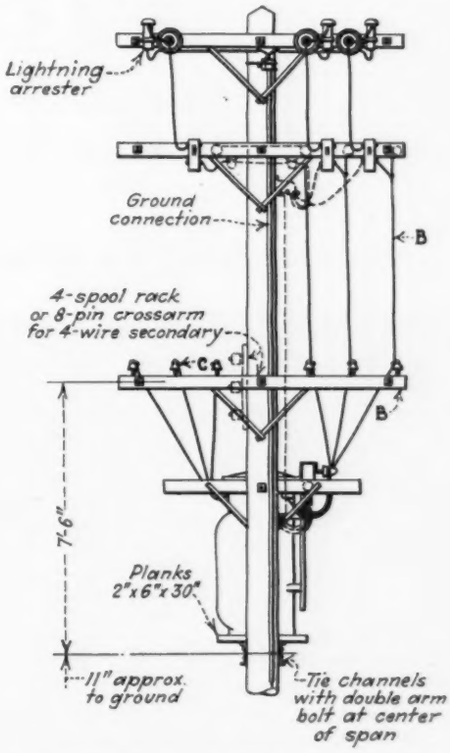
The type of man best fitted for this particular job is one with a good education and several years of operating experience, having come up from the ranks by sheer merit. He must be a quick and logical thinker, cool and composed during times of trouble. Such men are few and far between, and thus a real problem is presented when it is necessary to increase the personnel as at present under code regulation of hours of labor, unless careful preparations have been made.

The Central Maine dispatching department functions under the immediate direction of the company's operating engineer, with headquarters at Augusta. At headquarters there are one relief and three regular dispatchers, the first named being required by the 48-hour week, and as the code's 40-hour week takes effect this personnel will be increased still more. These men are responsible for the scheduling of plant and line operations for the entire system. Working under their supervision are sub-dispatchers at the Gulf Island hydro-electric plant and at the Sewall Street substation in Portland. The Gulf Island sub-dispatchers handle the transmission network and plants in the western area, subject to Augusta orders. Those at Portland handle the Cumberland County system on a similar basis, subject to the approval of the headquarters dispatchers.

▼ ▼ ▼

Pole Platform for Transformers





For outdoor transformer installations on pole platforms up to 7,500 volts and for capacities ranging from three 25-kva. to three 100-kva. units inclusive the standard structure illustrated has been approved for the New England Power system. The following comments are included in the specifications:

(A) In general, install the top arms at right angles to the incoming primary line. Omit one arm and deadends if the line continues straight through.

(B) Open drop wiring, from cutouts to primary bus, is preferred arrangement when secondaries are carried on crossarms. When rubber-covered wire (in fiber conduit down pole) is used with secondaries on racks, omit bus crossarms.

(C) Spool clevise deadends should be used for bus wires larger than No. 1/0.

(D) Cross-member to steady transformers, not to support transformer weight.

(E) When soil conditions are poor, i.e., swampy, a four-pole transformer platform or suitable reinforcement of the two-pole structure may be required.

South and West More Active

Industrial activity in the Southern States was 6.5 per cent greater in September than in August, it appears from returns received by ELECTRICAL WORLD giving energy consumption in plants engaged in various kinds of manufacturing. The weighted average came within 3 per cent of equality with that for July, which remains the highest month thus far in the period of recovery. Although September of last year established a temporary peak for that section of the country the record of that month was surpassed by nearly 13 per cent.

A sharp recession in operations of one large iron and steel plant lowered the index for that industry, compared with the preceding few months, in the face of gains in smaller plants. But the rate of activity remains 25 per cent greater than in May and 10 per cent above September, 1932, by a wide margin the peak month, after February, of that year. With the exception of this and the rubber products industry the movement from August was upward. The stone group alone lost by comparison with September of 1932, but outranks both August and October of that year.

Reports from the Western States give a weighted average 4 per cent above August, 21 per cent above September of last year and closely approaching July. Conspicuous features are the steady, if slow, upward progress of the metals group, though receipt of delayed returns may necessitate revising the September figure. Activity in construction is indicated by the rise in lumber and in the stone, clay and glass group.

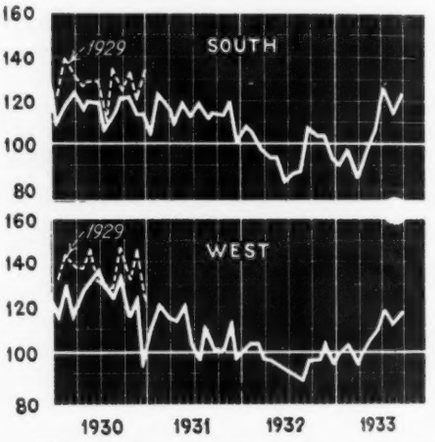
Index of monthly manufacturing activity, South and West

Base: Average month 1923-1925 = 100

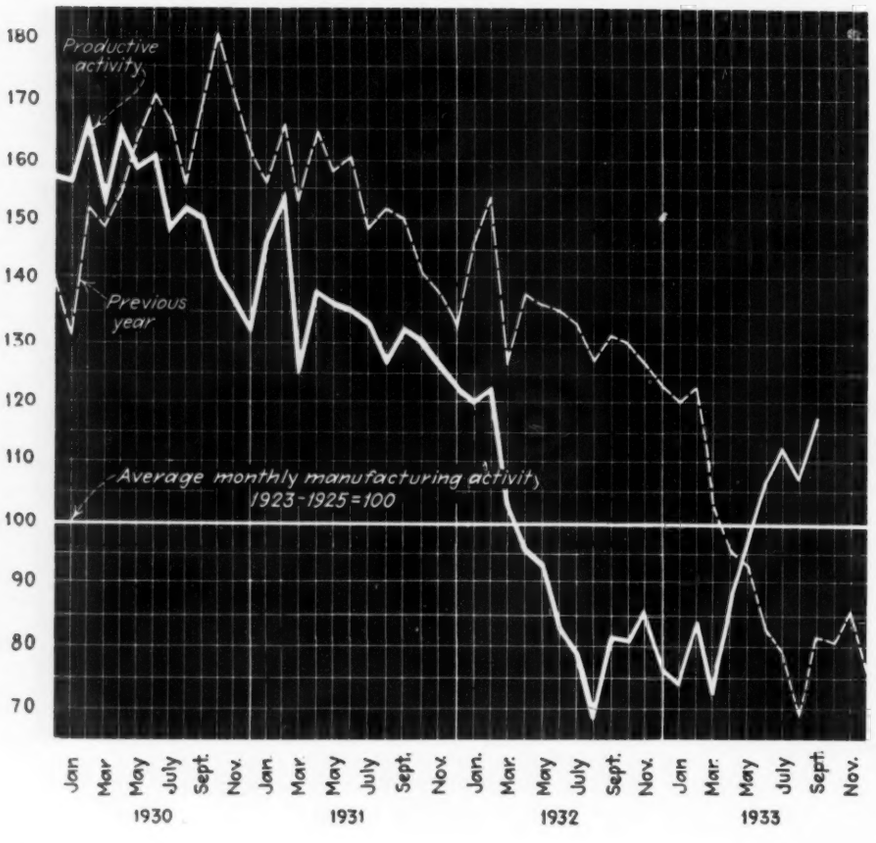
(Corrected for number of working days, but not for seasonal variation)

Industrial Groups	South					West				
	Sept., 1933	Aug., 1933	July, 1933	June, 1933	Sept., 1932	Sept., 1933	Aug., 1933	July, 1933	June, 1933	Sept., 1932
All Industry	**122.4**	**114.8**	**125.7**	**121.3**	**108.5**	**116.5**	**111.7***	**118.3**	**111.6**	**96.0**
Chemicals	181.0	154.0*	155.0	147.4	144.0	85.0	80.0	87.5	74.7	84.2
Food products	171.7	156.5	170.7	163.4	171.6	119.3	115.8	132.2	126.0	120.0
Iron and steel	117.2	147.8	145.0	127.1	107.1	....	....	....	....	....
Metal working	99.1	95.2*	99.7	88.5	61.2	....	....	....	....	....
Metals group	109.3	124.5*	124.8	110.0	87.0	76.2	71.4	70.3	62.2	38.4
Forest products	52.8	51.6	54.4	49.6	44.1	165.0	154.5*	156.0	154.0	121.2
Paper and pulp	182.1	167.8*	173.6	167.5	142.2	138.2	134.0	150.3	159.7	135.4
Rubber products	121.0	135.8*	148.4	146.3	86.8	97.0	108.7	125.3	106.0	84.5
Shipbuilding	....	....	....	....	....	113.0	117.2	113.6	107.2	108.0
Stone, clay and glass	120.5	89.3	121.0	137.0	143.2	121.0	116.0	118.0	107.8	81.3
Textiles	124.8	123.0	146.0	146.3	105.3	....	....	....	....	....

*Revision.



Electrical Works Maintain Gains



Electrical manufacturing plants operated at an average rate 9 per cent greater in September than in August, measured by energy consumption, as reported to ELECTRICAL WORLD. The showing thus made is the best since February, 1932, and marks a continuation of the advance begun last spring, now amounting to 50 per cent over the level then prevailing.

Manufacture of domestic appliances, especially in the North Central area, is picking up vigorously, to judge from those reports that can be identified as typical of that group. Making of equipment for permanent construction appears, in general, to have turned moderately downward.

Monthly Index of Electrical Manufacturing Activity

Adjusted to 26 working days

Base: Average Month, 1923-1925

Month	1930	1931	1932	1933
January	156.2	146.6	120.0	74.0
February	165.2	154.3	122.2	83.3
March	153.0	126.1	102.9	75.0
April	164.9	138.1	95.6	89.4
May	158.0	136.7	92.8	104.1
June	160.2	135.2	83.1	106.9
July	148.5	133.4	79.2	114.0
August	152.2	126.9	67.6	108.4
September	150.0	132.6	81.4	115.2
October	140.6	130.4	80.9	....
November	137.5	126.9	85.6	....
December	132.4	123.5	76.0	....

Reversed Cooling for Heat An Economic Combination

By C. D. GRAHAM

Supply Engineering Department,
Westinghouse Electric & Manufacturing Company,
East Pittsburgh, Pa.

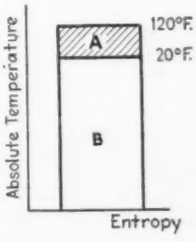
REVERSED refrigeration is often referred to as a "heat pump," since the driving mechanism (such as a motor) merely serves as the motive force to pump heat from one point or medium to another. This is true when either heating or cooling, but in heating the heat equivalent of the energy input may be added to the total heat output. Thus, the equipment has a better performance as a heater than as a cooler.

The performance of an inverted refrigeration plant is measured by its "coefficient of performance," which may be defined as the ratio of the total heat delivered to the heat equivalent of the electrical energy consumed by the plant. For example, if five B.t.u. of heat is supplied to the house for every one B.t.u. of electrical energy consumed then the coefficient of performance is 5. This apparently absurd performance is explained by the fact that four units of heat flow from the outside air to the refrigerant in the evaporator and are liberated in the house by the condenser for each heat unit of electrical input. Thus, the motor not only delivers its direct heat energy but also serves as the motive power to pump the heat from outside to inside. A graphical interpretation of this coefficient of performance can be obtained by plotting the cycle on the temperature-entropy plane (Fig. 1).

Half of ideal coefficient derived in practice

Of course the performance of an actual plant is not as good as that of an ideal plant operating between the same temperature limits. In order for heat to flow from the outside air at 20 deg. F. to the refrigerant within the evaporator coil, a temperature gradient must exist; i.e., the refrigerant must be at a temperature lower than 20 deg. F. Similarly, the refrigerant in the condenser must be at some temperature higher than 120 deg. F. if the air is to be heated to this desired temperature. It is evident that the coefficient of performance is decreased by these changes since the shaded area in Fig. 1 is increased. Besides the necessity of a temperature gradient, neither the compression nor the expansion takes place in the frictionless, adiabatic manner assumed in Fig. 1. The fact that the vapor is superheated on being compressed further reduces the coefficient of performance. Finally, the inefficiency of the compressor and of the motor must be considered, so that the coefficient for an actual plant operating under the temperatures assumed would probably be about $2\frac{3}{4}$ instead of 5.8 as for the Carnot cycle.

Field experience and test data are meager, but from a purely thermodynamic analysis of the problem it is evident that the coefficient of performance will be increased with decreases in the temperature gradient or with increases in the quantity of air handled through the equipment. For example, the efficiency of the cycle is increased if, instead of bringing the outside air to within 20 deg. of the evaporator temperature and the inside air to within 20 deg. of the condenser temperature, the air is allowed to come to within 4 deg. of the evaporator and condenser temperatures respectively. Also, if the heat distribution end of the system handles a sufficient air quantity to allow the building to be heated with, say, 80 deg. air the coefficient of performance would be greater than if the system were designed to heat to the desired temperature with air at a discharge temperature of 120 deg. Of course, the increased size of the evaporator and condenser in order to get the lower



The shaded area (A) represents the heat equivalent of the electrical energy consumed; area B represents the heat supplied to the system by the outside air and the total area (A + B) represents the heat ejected by the system to the house. The coefficient of performance, then, is the ratio of the total area (A + B) to the shaded area A. Assuming the outdoor air temperature to be 20 deg. F. (480 deg. absolute) and the air being delivered to the house to be 120 deg. F. (580 deg. absolute) the value of this coefficient of performance for the ideal case shown is 5.8.

Fig. 1—Carnot cycle shows ideal factor of performance

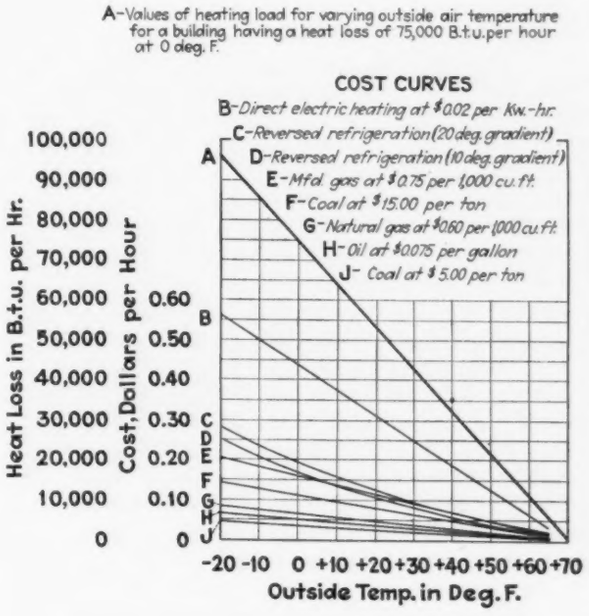


Fig. 2—Reversed refrigeration half as costly as direct electric heat

It should be recognized that the figures represented by these curves are largely theoretical and that experimental data which are being gathered at the present time will most probably alter the picture to some extent.

temperature gradients and greater air quantities will increase the initial cost of the installation.

While the final answer on many points such as the economic balance between temperature gradients and air quantities can only be determined from experimental installations, yet a thermodynamic analysis of the problem brings out some interesting points. The results of an extensive theoretical study have been summarized on a single curve sheet which is presented here (Fig. 2).

Basic Heat Requirements (Curve A, Fig. 2)—A specific small house was chosen in which a refrigeration machine might be installed and it was estimated that 75,000 B.t.u. of heat energy per hour would be required to maintain an indoor temperature of 70 deg. F. when the outdoor temperature was 0 deg. F. The assumption was made that the coefficients of heat transmission through the walls of the structure were constant—that is, unaffected by the temperature difference through them—and that the heat energy required per hour to maintain 70 deg. indoors was at all times directly proportional to the difference in temperature between the outside and the inside of the building. Actually, the heat transmission through building construction does not follow a straight line relation, but within the temperature range of this study the error involved is negligible.

To express this situation graphically the straight line *A* on the curve sheet was used. When the outdoor temperature (which is the independent variable) is assumed to be 70 deg. F. the temperature outdoors will be the same as that indoors and there will be no transfer of heat energy through the walls. Consequently, no heat energy will be required from the machine which is installed to heat the building. When the outdoor temperature is 0 deg. F. 75,000 B.t.u. will be required from the machine which is to furnish the necessary heat energy required to maintain the indoor temperature at a constant value of 70 deg. F. For any other value of outdoor temperature the amount of heat energy in B.t.u. per hour to maintain a constant indoor temperature can be taken graphically from this curve (outer left-hand scale) so that at —20 deg. F. it is found that 96,400 B.t.u. per hour will be required.

A curve similar to that represented by curve *A* can be constructed for any building in which the installation of heat equipment is contemplated. Then, with this curve in mind, the behavior of the equipment and its cost of operation can be predicted at least experimentally for any arbitrarily chosen outdoor temperature.

Efficacy of Reversed Refrigeration (Curves "C" and "D")—Knowing what conditions the building would impose on the installed equipment, as illustrated by curve *A*, a consideration of the behavior of the heat pump was next undertaken. A motor-driven compressor of conventional design was chosen which could deliver 96,400 B.t.u. of heat energy per hour into the building when the outdoor temperature was —20 deg. F. A suitable evaporator and condenser were also chosen to be used in connection with this compressor. The evaporator was to be located outdoors and in it the liquid refrigerant was to be converted into a vapor (the latent heat of vaporization being furnished by outdoor air moved over the evaporator surface). The condenser was to be located indoors in the air duct system of the building and in the condenser the hot compressed vapor was to be condensed (the latent heat of vaporization being given up, in this case, to the indoor air circulated over the condenser surface and through the building).

For simplicity the evaporator and condenser were assumed to have the same number of square feet of heat-transferring surface and it was understood that their functions could be changed so that the condenser suitable for winter operation would become the evaporator suitable for summer operation and the winter time evaporator would become the summer time condenser. The compressor was to be operated at all times under full load conditions on a start-stop schedule, the ratio of running time to total time being equal to the ratio of the heat required by the building (this quantity depending upon the outdoor temperature) to the total heat which the compressor could produce.

The behavior of the heat pump is a variable quantity and depends upon the outdoor temperature. To appraise this factor a theoretical study of the operation of the compressor was made and the results tabulated in terms of the coefficient of performance of the combined compressor-condenser-evaporator assembly.

Results compared at different temperature gradients

It was assumed that good engineering practice would allow a difference of temperature of 20 deg. F. between the hot vaporous refrigerant in the condenser and the indoor air circulated over the condenser surface and a like difference of temperature (20 deg. F.) between the liquid refrigerant in the evaporator and the outdoor air circulated over the evaporator surface. This quantity, 20 deg. F., is known as a 20 deg. F. gradient and applies to both the evaporator and condenser for the contemplated assembly. For the 20 deg. F. gradient outdoor temperatures of 60, 40, 20 and —20 deg. F. were assumed and the ratio of heat energy output to mechanical energy input (this ratio is the coefficient of performance) were computed for each of these outdoor temperatures. In these calculations available thermodynamic data for the refrigerant were employed and an imaginary indicator diagram of the compression-expansion cycle was constructed for each of the assumed conditions. From these diagrams the amounts of heat obtained, the amounts of mechanical energy consumed and their ratios were determined.

Other values of temperature gradients (10 and 4 deg. F.) were also assumed and corresponding indicator diagrams constructed in a manner similar to that employed for the 20 deg. F. gradient case. By extrapolation, values of the coefficients of performance were obtained for an assumed temperature gradient of 0 deg. F. In all cases for winter operation a register outlet temperature of 100 deg. F. was assumed. A summary of the results of these calculations are tabulated here:

Outdoor Temperature	Coefficients of Performance			
	20°F. Gradient	10°F. Gradient	4°F. Gradient	0°F. Gradient
—20°F.	2.07	2.36	2.57	2.75
0°F.	2.37	2.77	3.05	3.27
+20°F.	2.77	3.34	3.77	4.15
+40°F.	3.41	4.22	4.89	5.60
+60°F.	4.23	5.67	7.04	8.50

An approximate idea of the significance of the temperature gradient can be obtained when a comparison of the different cases is made. When the case of a gradient of 20 deg. F. is considered a specific amount of heat interchanger surface area for both the condenser and evaporator must be provided. If the gradient is changed to 10 deg. F. the surface area of both the condenser and evaporator must be approximately doubled and their first costs raised to double the value of the 20 deg. F. gradient heat interchangers. Lowering the gradient from 20 deg. F. to 4 deg. F. means increasing the surface area and the first costs of the evaporator and condenser to values five times those needed for the 20 deg. F. gradient. When the gradient is reduced from 20 deg. F. to 0 deg. F. the areas and costs are increased to infinite values. (Thus, the 0 deg. F. gradient gives the maximum theoretical coefficient of performance for 100 deg. register temperature).

Using the assumed outdoor temperatures for which the coefficients of performance of the heat pump had been determined and knowing the amounts of heat energy required by the building at these temperatures, the costs of heating could be computed first in terms of kilowatt-hours per hour and then in terms of dollars per hour. From this curves *C* and *D* were obtained.

Electrical energy was assumed to cost 2 cents a kilowatt-hour. (This value is lower than ordinarily encountered in this country,

but having determined the cost in terms of electrical energy at 2 cents per kilowatt-hour, the cost in terms of electrical energy at any other rate can readily be computed). If the coefficient of performance is 1.0 (as would be the case if direct electric heat is used) 1 cent will buy 1,706 B.t.u. of heat energy. For a coefficient of performance of 2.0, 1 cent will buy 3,412 B.t.u. of heat energy, etc.

Auxiliary power requirements for reversed-refrigeration

In the construction of curves *C* and *D* account was taken of the two items: (1) Cost of circulating the indoor air over the condenser and through the interior of the structure. (2) Cost of moving the outdoor air over the evaporator surface.

For direct electric heating and a coefficient of performance of 1.0 curve *B* was obtained for assumed values of outdoor temperature and corresponding heat requirements of the building, the ordinates being costs in terms of dollars per hour of operation (inner left-hand scale).

Relative cost with coal, gas and oil

For coal the assumption was made that the efficiency of combustion is 40 per cent and independent of the outdoor temperature. (When the entire heating season is considered this efficiency of combustion is somewhere near average for residential, hand-fired boilers.)

Coal (Curve F)—If coal costs $5 a ton, and if it has a heat energy content of 12,500 B.t.u. per pound and is burned with an efficiency of combustion of 40 per cent, it will cost $0.048 to produce 96,400 B.t.u. of heat energy. This amount of heat energy is required to maintain for one hour an indoor temperature of 70 deg. F. in the building under consideration when the outdoor temperature is —20 deg. F. and the fuel cost of maintaining this temperature is, then, $0.048 per hour. This value gives the ordinate at the left-hand extremity of curve *J* and a straight line is drawn through this point and the value 0 at an outdoor temperature of 70 deg. F. From this curve the hourly fuel cost at any assumed outdoor temperature can be determined when coal costs $5 a ton.

The cost of coal being an uncertain value which is different in different localities, it was decided to give the data pertaining to coal for $15 per ton as well as $5 per ton. Thus, if coal costs $15 a ton, the fuel cost of maintaining an indoor temperature of 70 deg. F. for one hour when it is —20 deg. F. outdoors is triple what it is when coal costs $5 a ton, or $0.144 an hour. From this value curve *F* was constructed.

Natural Gas (Curve G)—It was assumed that natural gas might have a heat content of 1,000 B.t.u. per cubic foot and that it could be burned with an efficiency of 70 per cent. One thousand cubic feet of this gas might cost 60 cents. The cost of producing 96,400 B.t.u. by burning this gas would be $0.0825. This gives a convenient point at the extreme left hand extremity of the straight line curve *G*, from which the hourly cost of heating the assumed building can be determined for any outdoor temperature with natural gas as fuel.

Manufactured Gas (Curve "E")—Manufactured gas having a heat content of 500 B.t.u. per cubic foot, costing $0.75 per 1,000 cu.ft. and burned with an efficiency of combustion of 70 per cent, will enable the building to be heated satisfactorily when the outdoor temperature is —20 deg. F. with a fuel cost of $0.206 per hour. This calculation made possible the construction of curve *E*.

Oil (Curve "H")—If oil containing 150,000 B.t.u. per gallon can be purchased for 7½ cents a gallon and burned with an efficiency of combustion of 70 per cent, the hourly fuel cost of heating the building would be about $0.0685 when the outdoor temperature is —20 deg. F. From this one value curve *H* was constructed.

Conclusions and speculation

The chief advantage of reversed-refrigeration is its extreme simplicity of control. A simple thermostat to start the compressor when the temperature falls below the setting and to stop it when the temperature rises above the desired point is all that is required. Such a system would require no attention from the user and is entirely free from dirt.

If energy can be purchased for 2 cents a kilowatt-hour the operating cost of a heat pump in normal winter weather is about the same as the operating cost of a furnace using manufactured gas at 75 cents per 1,000 cu.ft. With electrical energy at this same unit cost the operating cost of the heat pump (in average winter temperatures) is a little greater than a heating system using coal at $15 a ton and is also greater than a system using manufactured gas at 60 cents or oil at 7½ cents a gallon. But even under the worst assumed conditions and regardless of the unit cost of electrical energy the operating cost of the heat pump is not greater than one-half the cost of operation of direct electric heating equipment.

A more favorable outlook is obtained when another view of the situation is investigated. The problem of establishing comfortable indoor temperatures in hot weather is one demanding immediate consideration. Compressor machines seem to possess advantages over most forms of equipment which have been proposed for cooling buildings and their installation on an extensive scale is an alluring possibility. With these considerations in mind the prospects appear to be good that, as time goes on, more homes will be equipped with compressor machines suitable for maintaining indoor temperatures at comfortable levels in the hottest weather.

Building-insulation would help cooling economy

If summer cooling is accepted as a necessity, modifications in building construction would be expected to follow in which the fixed costs of structures would be increased (particularly by employing a generous amount of heat insulation material in their fabrication) to a point where they are in economic balance with the operating expenses chargeable to their cooling equipment. When that happens, the possibility of economical winter heating by compressor machinery becomes much more attractive than it is at the present time because the compressor equipment will already be installed and the building will be built to provide for economical summer operation of the machines. Consequently, the heat requirements in winter will be much lower than required by present methods of construction.

A factor in this situation which will encourage the use of the same machine for heating and cooling is that compressor equipment seems to deteriorate less rapidly if it is not subjected to long periods of inactivity. This means, if it is at all practicable, year-round operation of the equipment is highly desirable.

If the fixed charges of improved building construction and the fixed charges of the cooling equipment can be assigned entirely to the period of summer operation and only the operating expenses charged to the period of winter operation the inducements to use the heat pump for heating buildings are greatly augmented.

In the New York district it is estimated that a compressor sufficiently large to cool an uninsulated building in summer will be suitable for heating the same building in winter when the outdoor temperature is not below freezing. If a standby source of heat is available the compressor can be used to satisfy the heating requirements for perhaps one-half of the entire heating season. In those regions where outdoor temperatures reach freezing as a minimum the same compressor could be

used for year-round air-conditioning purposes. Even in New York's climate it is evident from the curves that with favorable electrical energy rates the operating cost of the heat pump in its present form will compare satisfactorily with those of competitive heating devices for outdoor temperatures in the region of 70 deg. F. down possibly as low as 40 deg. F.

In the present state of development it appears that reversed-refrigeration heating is economically sound only where summer cooling will also be required. A possible exception to this general view is that in certain localities the cost of basements is prohibitive on account of ground water conditions. In such places it may be that the heat pumps for heating only will be popular in that the greater first cost is more than offset by the saving in construction, as the equipment may be placed at any convenient location, such as the attic or garage.

Some experimental work has already been done with cooling devices in houses, and while it is too early to reach general conclusions, one specific bit of data can be mentioned. During extremely hot weather (which included at least one record-breaking day) the power requirements for a Pittsburgh domestic air-conditioning installation in a house having a volume of about 10,000 cu.ft. were:

(1)	Compressor (indoors)	3,700 watts
(2)	Condenser fan (outdoors)	350 watts
(3)	Evaporator fan which also circulated the indoor air (indoors)	350 watts
	Total	4,400 watts

With electrical energy at 2 cents a kilowatt-hour this would mean an hourly cost of $0.088. By making conservative estimates as to what can be accomplished in improving the efficiencies of all the parts of the equipment, it is estimated provisionally that satisfactory cooling of an entire house of fairly good construction, but without any special heat insulation and with a volume of about 10,000 cu.ft., can be accomplished in Pittsburgh in extremely warm weather with an expenditure of about 50 kw.-hr. of electrical energy in a 24-hour day.

With energy available at 2 cents a kilowatt-hour this

Industrial Lighting—a Job Far from

Pointing out that American industry is mechanized to the extent of 4.2 hp.—3,133.2 watts—per worker on the average, but uses only 0.63 watt average per square foot to light the spaces in which the worker is occupied, Charles Poey, New York & Queens Electric Light & Power Company, urged that more effort should be made

Lighting Survey of 2,907 Industrial Plants in

Tabulated August 1, 1933

Classification of Manufacture	Per Cent Employed Compared with Normal	Federal Census No. of Plants of This Type	Per Cent of Plants Surveyed Using Mazda Lamps	Average Maintenance Cost of Lighting per Year per Plant	Maintenance of Lighting	Estimated Replacement Cost for Good Lighting	Average Age of Present Lighting Equipment in Years	Average Foot-Candle Intensity	Average Connected Load for Lighting (Kw.)	Average Maximum Demand for Lighting (Kw.)	Average Energy Costs per Kw.-Hr.	Per Cent Increase in Light Necessary for Good Illumination	No. of Accidents due to Poor Lighting	Most Popular Type of Reflecting Equipment Now Used in Per Cent	Average Size and Type of Lamp Now Used	Watts per Square Foot (Average)	Per Cent of Plants Using Obsolete Reflecting Equipment
Baking	70.0	15,684	97.3	$97.50	Average	$1,230.00	7.5	1.24	25.92	20.7	$0.031	195.0	No Reports	Shallow Dome	100 W A	0.29	32.1
Building materials	56.0	14,792	65.0	55.25	Poor	410.00	8.1	0.5	7.1	3.6	0.042	1,500.0	65	Misc.	50 W A	0.18	82.0
Canning	83.5	2,917	93.3	62.10	Poor	1,250.30	11.7	0.6	27.3	17.1	0.021	1,150.0	3	Misc.	60 W A	0.31	83.4
Chemical manufacturing	41.3	8,871	57.2	15.03	Poor	627.30	9.3	1.3	22.5	16.1	0.027	208.0	22	Shallow Dome	60 W A	0.3	81.7
Foodstuffs, candy, dairy	98.1	46,113	70.0	172.14	Average	493.50	8.9	3.1	31.4	22.8	0.022	271.0	No Reports	15% RLM 18% Encl Gl	150 W PS	0.83	65.2
Glass	65.0	8,478	92.0	49.60	Poor	161.50	5.6	1.2	18.7	7.0	0.027	460.0	No Reports	Shallow Dome	100 W A	0.26	35.0
Laundry	57.0	21,926	51.3	28.14	Average	290.15	5.5	4.75	9.86	7.32	0.045	139.0	3	RLM	200 W PS	0.83	41.3
Leather goods	45.2	4,796	65.9	147.12	Average	475.15	6.5	6.88	24.2	14.1	0.025	62.5	No Records	RLM	150 W PS	1.3	33.7
Machinery and tool manufacturing	37.3	11,807	60.0	89.43	Average	745.45	6.57	5.1	51.69	41.81	0.03	106.5	6	RLM	200 W PS	1.05	27.3
Metal working	39.2	12,021	73.4	19.37	Poor	614.18	9.7	1.3	11.71	6.83	0.031	562.3	14	RLM	75 W A	0.52	63.7
Paints and varnishes	61.3	923	81.3	31.13	Very Poor	1,507.33	17.1	1.4	2.07	1.6	0.028	494.0	83	3% VP 12% RLM	60 W A	0.41	87.3
Printing	27.3	22,725	76.7	109.20	Average	742.83	5.4	5.5	26.54	14.65	0.037	109.8	9	RLM	150 W PS	1.03	37.6
Pulp and paper manufacturing	65.0	3,783	95.0	175.00	Average	2,011.00	10.0	5.29	76.3	51.4	0.028	193.0	No Reports	RLM	150 W PS	0.33	25.0
Refining	61.0	2,906	91.3	140.07	Average	2,103.50	6.8	0.02	6.5	4.3	0.018	592.5	19	RLM	150 W PS	0.45	72.0
Rubber products	42.7	498	79.3	63.25	Average	607.28	7.2	0.8	11.9	6.3	0.036	496.0	1	RLM	75 W A	0.6	67.3
Shoe manufacturing	67.3	1,460	87.7	147.03	Average	596.25	4.3	1.8	14.9	10.3	0.024	263.0	1	Local Lighting	60 W A	0.52	63.4
Textiles and clothing	43.1	24,443	79.0	407.80	Average	107.23	5.3	7.0	43.2	25.9	0.039	115.2	32	18% RLM 6% G S 14% Encl Gl	200 W PS	1.07	21.3
Woodworking	70.0	16,527	83.5	15.00	Poor	625.08	4.0	3.6	19.0	11.6	0.034	367.0	14	RLM	100 W A	1.1	62.4
Totals and averages	57.8	220,670	77.8	$101.34	Average Minus	$811.01	7.74	2.85	23.93	15.74	$0.031	404.7	272	32.1% RLM	121 Watts Actual 150 Watts Nearest Standard	0.63	54.5

would mean a daily expenditure of $1. This expenditure may not seem attractive, but when a person has had the privilege of enjoying a comfortably cool day at home in the middle of a period of record-breaking hot weather the cost of the comfort shrinks to insignificance. As more and more people get to know from direct experience what comfort cooling means in terms of its influence upon their own mental and physical reactions the inducements to install the equipment will be increasingly evident. After its installation, the inducement to use the same equipment for heating purposes, especially through those periods when the weather favors economical operation of the machinery, will follow as a matter of course.

Interest in year-round conditioning will increase

In a general sense, as time goes on, it seems reasonable to expect a combination of three circumstances:

1. At least a gradual improvement in the methods of construction of buildings with their heat losses brought to lower and lower levels.
2. A constantly growing interest in summer comfort cooling, with the reasonable prospect of compressor equipment being widely used.
3. A gradual lowering of the costs of electrical energy as predicted on the basis of existing trends.

With these three things in mind, and neglecting the possibility that a new approach to the solution of the year-round air-conditioning problem may be devised, the future can be faced with the assurance of an increasing interest in the heat pump and its possibilities for cooling and for heating buildings.

▼

Accomplishment

to improve industrial lighting at the recent convention of the Illuminating Engineering Society and presented the accompanying tabulation.

182 Cities and 22 States

Survey Data Developed on Latest Federal Census

No. of Wage Earners	Total Horsepower in Connected Load for Light and Power	Horsepower per Wage Earner	Size Market by Replacing Obsolete Reflecting Material Only	Connected Load (Kw.) for Lighting Assuming Light to Be 60 Per Cent of Load	Estimated Yearly Revenue If Obsolete Plants Were Modernized Based on Three Hours Daily Use	Total Market Including Wiring, Material, Labor and Energy
152,411	217,286	1.6	$6,193,050	91,255	$2,546,014	$8,739,054
620,171	2,790,122	4.6	5,054,890	1,318,849	57,412,592	62,467,482
95,396	217,017	2.3	2,776,916	130,210	2,460,969	5,237,885
381,075	2,984,913	9.6	5,546,670	1,790,947	46,220,012	51,766,682
664,770	388,195	0.5	13,836,538	232,917	4,611,756	18,448,294
353,036	2,348,157	7.9	479,180	1,408,894	34,236,124	34,715,304
152,362	210,462	1.6	2,627,308	126,277	5,114,218	7,741,526
368,331	2,714,377	9.0	767,842	1,528,626	34,294,085	35,061,927
858,843	2,724,372	3.4	1,569,277	1,634,623	34,413,482	35,982,759
444,918	1,452,978	3.5	250,722	871,788	24,322,885	24,573,607
25,490	143,111	6.0	2,420,039	85,866	1,911,823	4,331,862
296,324	458,852	1.4	258,662	275,311	9,167,056	9,425,718
116,834	836,932	7.7	1,902,406	503,159	12,679,606	14,582,012
151,325	523,842	3.5	4,400,522	314,305	5,001,741	9,402,263
141,121	656,857	4.6	226,638	394,114	12,469,293	12,695,931
206,992	139,569	0.6	552,127	83,741	1,808,805	2,360,932
1,627,141	3,986,136	2.6	558,239	2,391,681	83,948,013	84,506,252
327,519	859,953	2.6	6,446,450	515,971	15,788,712	22,235,162
6,984,059	23,652,771	4.2	$55,867,476	13,698,534	$88,407,186	$444,274,652

One Engineer's Opinions on Turbine-Oil Fires

Two characteristics which seemed to be common to the destructive fires associated with steam turbine installations in the last few years are: (1) They occurred where fairly high steam temperatures are used; (2) the principal source of destruction was lubricating oil. In most instances the principal damage occurred in the station structure, particularly the roofing. The turbines themselves often miraculously escaped severe damage and in no instance was a member of the operating force hurt seriously.

Close proximity of hot steam parts and combustible oil in the valve-operating gear is undoubtedly one of the greatest fire hazards in modern high-temperature installation, says C. R. Soderberg.* Whether the valves are placed on top of the cylinders or in separate steam chests at the side of the cylinder does not seem to be of fundamental significance, he declares, because serious oil fires have occurred on both types of arrangements. However the former arrangement may contribute to more extensive damage of the turbine parts.

The precaution of operating valves by mechanical linkages from pistons, located at appreciable distances from the valves, is always a possibility, but the resulting complications are very objectionable, Mr. Soderberg asserts. The most attractive solution, in his opinion, is a non-combustible lubricating medium. While compounds are already on the market for which satisfactory lubricating properties are claimed, the finding of a synthetic non-combustible lubricant meeting the elaborate requirements placed on lubricating oil would be nothing short of a miracle.

Pending the development of such a lubricant it is possible to separate the governing and lubricating systems, suggests Mr. Soderberg. Many liquids may be used as a governing fluid, since the requirements are simpler. Water may eventually become possible, although the corrosion problems are difficult to anticipate. At present there are a few turbines in operation using "Aroclor" as a governing fluid. This compound, which is obtained by chlorination of diphenol, may also have satisfactory properties for lubrication.

Careful attention to piping arrangements and details, covering of hot steel surfaces, introduction of drip pans to carry away probable leakage of oil, wider separation of oil tanks from turbines, coupled with fireproof housings and facilities for quick drainage in case of fire, are other precautions suggested.

**Manager turbine division, Westinghouse Electric & Manufacturing Company.*

Paper Machine Modernized by

By D. F. CRONIN* and C. W. DRAKE†

INDICATIVE of the progress that is being made in the use of electronic tube equipment in industry is the speed regulator installed on a 350-hp. d.c. motor driving a paper machine, where for 24 hours a day a few small tubes maintain an exact speed over a range of operating speeds of 12 to 1. The Cherry River Paper Company of Richwood, W. Va., has recently completed the modernizing of a 30-year-old paper machine which is now one of the most economical and interesting machines in the country. Originally this 138-in. Fourdrinier machine was driven by a twin-cylinder variable-speed engine and had a speed range of from 150 to 300 ft. per minute.

In modernizing the paper machine numerous changes and improvements were made both in the machine and also in the drive. Old-fashioned bevel pinions and mortise gears were replaced with modern gear units and improved methods of lubrication on the machine made possible higher operating speeds with much less maintenance and repairs than previously. The final range of the rebuilt machine is from 75 to 900 ft. per minute, the low speed being used for 250-lb. solid bleached sulphite and the high speed for 20-lb. bread-waxing paper. Between these extremes many grades and weights of white bond, envelope, special bleached sulphite, folders, tags, etc., are manufactured.

The sections of a paper machine on which the liquid stock is formed into a sheet of paper, dried and delivered as finished product are in many cases connected by belts to a line shaft known as the "variable speed line." The pumps supplying the liquid stock to the machine are connected to another shaft known as the "constant speed line." The speed of the variable line is adjustable over a wide range to accommodate the manufacture of various weights and grades of paper, but it is evident that when once adjusted, any change in its speed with a constant flow of stock produces a proportional change in the weight of paper being manufactured. Under present economic conditions and demands for

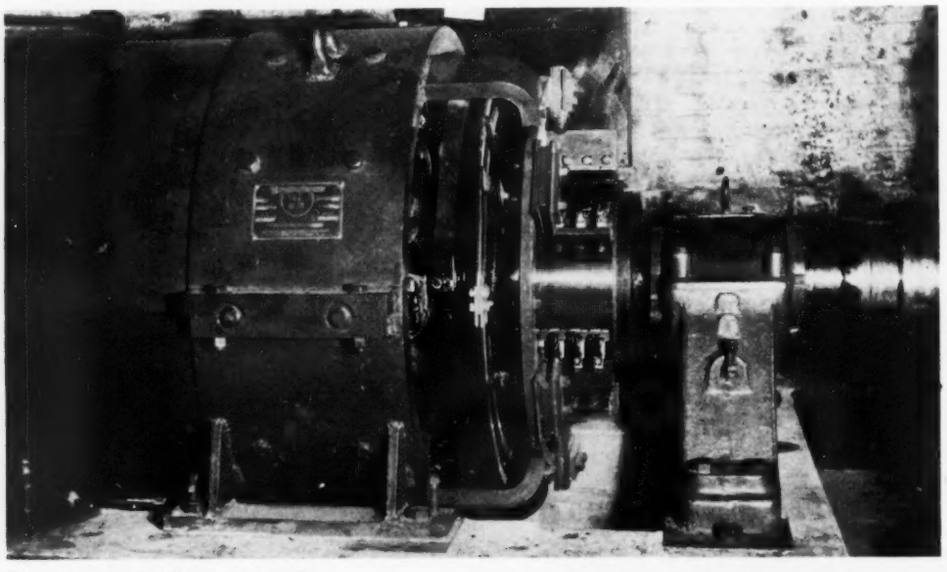


Fig. 1—A 350-hp., 230-volt, 34/425-r.p.m. motor drives "variable line" of paper machine. Inclosing covers for force ventilation on rear end only

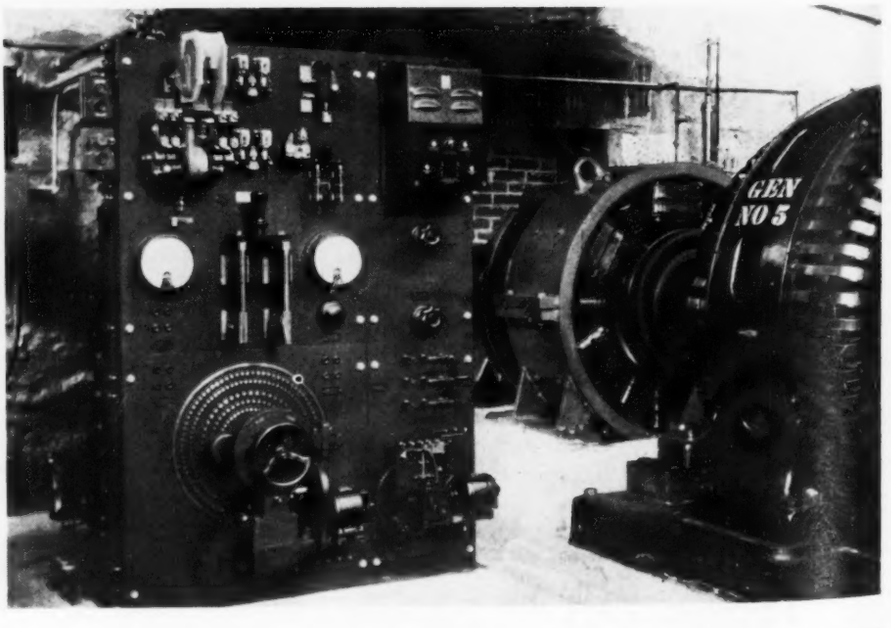


Fig. 2—Electronic regulator governs motor speed. Automatic control panel for 350-hp. paper machine motor showing electronic regulator in cabinet at top. At right is shown the 500-kw. a.c. and the 300-kw. d.c. generators which are driven by the non-condensing turbine

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Electronic Speed Regulator

strict adherence to specifications it is not surprising that the question of accurately maintaining paper speeds is of utmost importance.

Variable voltage d.c. drive adopted

After a careful study of local conditions and apparatus on hand which might be utilized, it was decided to install a variable voltage drive which uses one direct-current motor to drive the variable line. A motor to develop 350 hp. at the maximum speed was designed for coupling in the center of the variable line which had a speed range from 34 to 425 r.p.m. The motor is arranged for forced ventilation and will develop its rated torque continuously over the entire speed range.

In the power house there was already installed a 500-kw. alternating-current non-condensing Westinghouse turbo-generator which was used only as a spare, and it was decided to use this set as a power supply for the paper machine drive. A new shaft was pressed into the rotor of the a.c. generator and a new 300-kw., 250-volt direct-current generator was assembled on the same shaft. This generator supplies power to the 350-hp. motor and the speed range is obtained by a combination of generator voltage and motor field control.

Under operating conditions the alternating-current generator of this set is tied into the a.c. mill bus so that the speed of the set is maintained as steady as the main supply and an interchange of power is provided for between the 500-kw. non-condensing turbine and the condensing turbines in the mill power house. The non-condensing unit is equipped with an automatic steam regulating valve connected to the "regulator roll" on the driers so that just the amount of steam required for drying the paper is passed through the turbine. Any surplus power developed by this steam above that required to drive the direct-current motor is delivered through the alternating-current unit to the mill bus.

The power requirements of the paper machine motor vary approximately with the speed, but the steam requirements for paper drying generally increase as the speed decreases. On light-weight papers running at high speed, where comparatively little steam is required for drying, the "regulator roll" closes the inlet valve to the turbine, admitting very little steam. The a.c. generator on the turbine shaft floats on the line, sometimes giving a little power to the station bus and sometimes taking power from it as a synchronous motor. On heavy-weight papers running at low speed much more steam is passed through the turbine for drying purposes than is required for power to drive the paper machine. The excess power is then put back into the station bus through the a.c. generator on the turbine shaft. On all grades of paper between these two extremes the above conditions hold true, with varying relations as to speed, weight of paper and steam required for drying. There is no loss of steam or energy at any speed, weight or drying condition. In case of trouble with the turbine the steam supply may be cut off and the a.c. generator will automatically take up the load as a synchronous motor with no interruption in the operation of the paper machine drive.

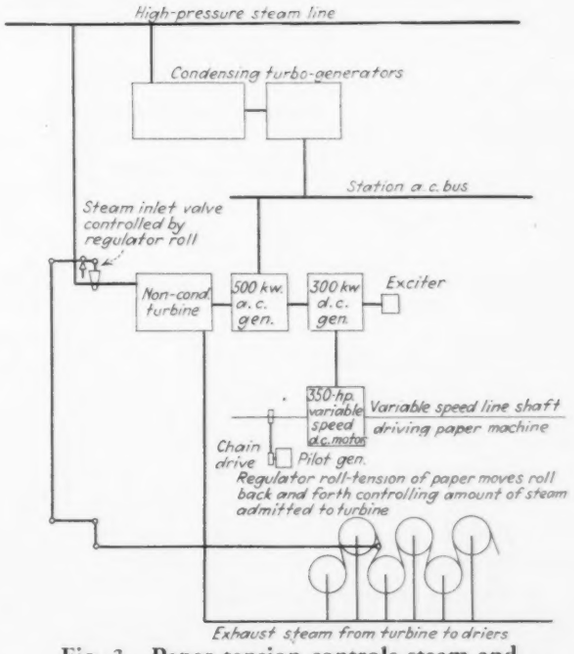
High-pressure steam line
Condensing turbo-generators
Station a.c. bus
Steam inlet valve controlled by regulator roll
Non-cond. turbine
500 kw. a.c. gen.
300 kw. d.c. gen.
Exciter
350-hp. variable speed d.c. motor
Variable speed line shaft driving paper machine
Chain drive
Pilot gen.
Regulator roll-tension of paper moves roll back and forth controlling amount of steam admitted to turbine
Exhaust steam from turbine to driers

Fig. 3—Paper tension controls steam and electric balance

Non-condensing turbine supplies low-pressure steam as required by the driers and surplus energy generated is returned to the a.c. mill bus.

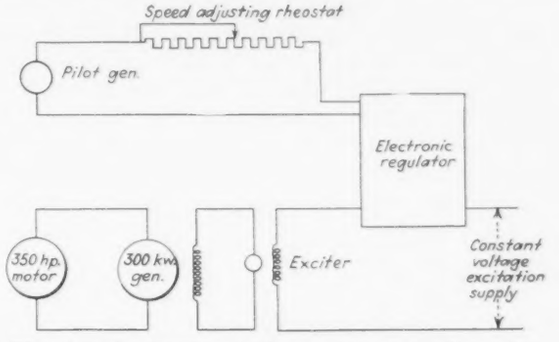

Fig. 4—Electronic regulator acts through exciter field from pilot generator

The control for the direct-current paper machine drive is of the full automatic type, permitting starting, stopping and adjustment of the motor speed from a set of master control pushbuttons located at a point convenient to the paper machine operators. To maintain the speed constant at any setting various types of regulators have been in use, among the most recent being the carbon pile type, but all types involved mechanical parts and motions. This installation is the first, however, to use the electronic type of speed regulator, which was designed to give improved sensitivity and general performance as compared with all previous types.

The electronic regulator is essentially a voltage regulator and operates to maintain constant voltage on a pilot generator driven from the machine line shaft. The voltage of this pilot generator is balanced against a small battery and any deviation from a balance operates through the tube circuit and an exciter to vary the armature volt-

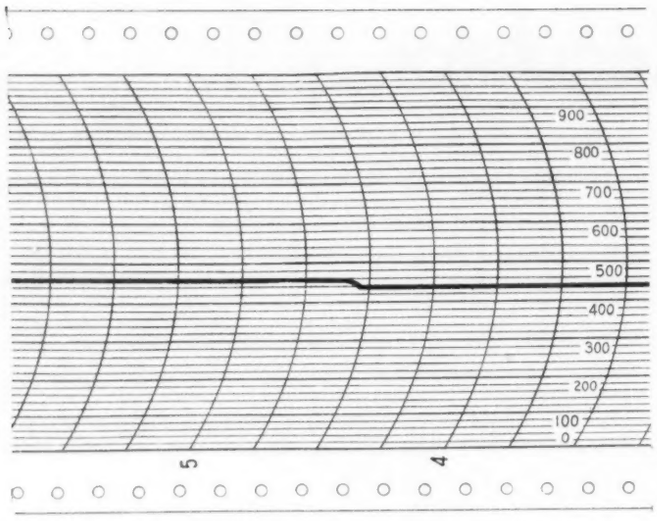

Fig. 5—Close speed regulation obtained
Only one speed change was made during this operating period, from 440 to 460 ft. per minute.

age of the main generator and restore the balance of speed and pilot voltage. A motor-operated rheostat is in series with the regulator and pilot generator and if it is desired to increase the motor speed the rheostat is moved to increase the resistance in the circuit and this in turn causes the regulator to raise the voltage and consequently the speed of the main motor until a balance is again obtained.

The regulator is provided with effective anti-hunting features which permit stability of operation over the entire speed range and has no moving mechanical parts which introduce friction and inertia and give an insensitive zone which affects the accuracy of the usual mechanical regulators. The speed of response of the electronic regulator is so rapid that sudden and wide changes of load, such as occur when clutching in the heavier sections of the machine, cause no disturbance on the remainder of the machine. This performance adds greatly to the economical operation of the paper machine by preventing unnecessary delays in threading the sheet or making machine adjustments.

Having no mechanical parts to need attention or adjustment, the original accuracy and speed are maintained at all times without attention or maintenance. Tubes when used in 24-hour service will eventually need replacement and spares are always carried on hand. This regulator has now been in service more than 7,000 hours without a tube failure, which shows that tube replacement is not a serious problem.

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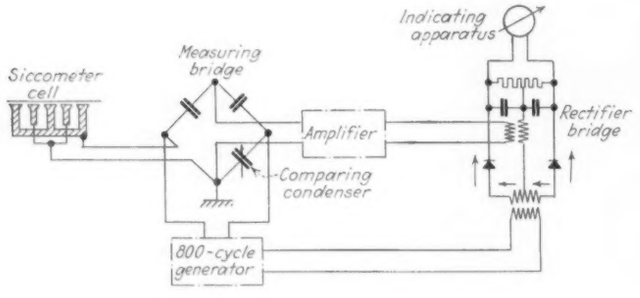
Siccometer Measures Moisture Content in Paper Production

Research has disclosed that low moisture content in the paper web emerging from a paper-making machine can be measured with high accuracy by having a condenser displacement current traverse the web in a transverse direction. On this principle Siemens & Halske have devised a siccometer which in reality has the two plates of its condenser on the same side of the paper and thus is practically unaffected by the variation in thickness of the paper.

In this design one plate of the condenser has 132 holes, into which there project as many pins which are paralleled to constitute the second plate. An 800-cycle generator supplies the power for the capacitance bridge which indicates on a zero-center meter the departures from standard values derived from a comparator condenser. Rectifiers are inserted so that the advantages of d.c. instruments may be derived at the low voltages involved. Used in conjunction with a chopper bar recorder which records every ten seconds and has a chart speed of 120 mm. per hour a continuous record of the percentage moisture is obtained. The proficiency of the operators in maintaining a predetermined level of moisture content is readily disclosed by the chart as well as momentary changes of moisture due to intermittent feed and interruptions.



Siccometer consists of condenser, bridge, amplifier, rectifier

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Retirement of Investment in Isolated Plants

Most industrial companies, particularly the smaller ones, should charge off the investment in power production machinery in about the same relation as they charge off other production machinery in their plant, which is usually five years or less. The total fixed charges, if the retirement period is but five years, are more than double the fixed charges which obtain if the retirement period is taken at twenty years.

It is poor practice for a small manufacturing company to use as long a period as twenty years in writing off investment in power plant equipment, as such companies should hold their plant investment to the minimum consistent with successful operation, and should try to write off their investment during good times to lessen the burden of overhead on bad times.

However, the retirement period really ought to be a flexible factor, depending upon the write-off practice, the future business outlook and past record of the particular industrial as they appear at the time the purchase of isolated power plant equipment is contemplated.

F. W. SHACKELFORD,
General Electric Company,
before Pennsylvania Electric Association.

The Contractors' Viewpoint on Wiring and the Code

By L. E. MAYER*
President National Electrical Contractors Association

IN almost every city in the United States the depression has brought about curtailment and in some cases elimination of electrical inspection activities. Departments have been reduced to the minimum. The moment we reduced those forces we made it possible for the bootlegging of wiring to develop. This naturally is of tremendous concern to electrical contractors. It not only takes work away from them, but it also reduces public appreciation of the ordinances which we have worked so hard to obtain. This breaking down of public morale with respect to wiring ordinances is not good. Bootlegging has also introduced cheap wiring and poorer wiring—wiring that never would stand inspection. This increases the public hazard.

Against rewriting the code

We need strong ordinances based upon the National Electrical Code and it is our hope that if existing ordinances are revised and new ones drafted there may be greater uniformity and better standards in electrical work. At the same time we realize that the National Electrical Code is a minimum despite the fact that there are interests that would destroy even this minimum. In 50 years the code has grown because of necessity. Every effort has been made to keep it as simple as possible, but in an art of such complexity as electrical wiring and with the growth of products and applications it has been necessary to have for the industry an intelligent code of installation. Any attempt to break down this code would be suicide for the entire electrical industry. In fact, it is the opinion of the National Electrical Contractors Association that in many cities the regulations of the National Electrical Code will have to be augmented by special rules to take care of special local conditions. It is our opinion, therefore, that instead of reducing the National Electrical Code to a very few simple terms it will be decidedly necessary, if we are to get any standardization in code interpretation and wiring installation, that the code become more detailed as years go on.

We appreciate the fact that much of the difficulty of the electrical inspector's job comes from violations made by electrical contractors. On the other hand, you must remember that there would be no necessity for your job if it were not for this fact. It seems, therefore, that we have much in common. Why is it, then, that your association and the National Electrical Contractors Association have not maintained closer contact? Are there not perhaps some things that we could work on jointly to the improvement of your work and our work and ultimately to the improvement of public safety and satisfaction with electrical service?

The job of reinspection

For more than 50 years we have been installing electrical work in buildings in this country. When the work was originally installed it was closely inspected. That work was put in by competent men who had pride in their work. Why is it that we have done nothing with those installations after they have been installed? Are those installations expected to live forever in spite of all of the abuse and tampering they have had from untrained people?

In other words, we have a reinspection problem in this country which only the electrical inspectors can solve. You put your O.K. on the work in the beginning and until you remove that O.K. the public is going to believe that the work is all right. It seems to me that as defenders of the public safety you are just as much concerned with the safety of the public after it occupies these buildings as you were before the buildings were occupied. We ask you to give consideration to that phase of your work and strive to develop plans for regular and systematic reinspection.

Contractor licensing

From your deliberations it is seen that you are interested in securing for your cities the services of only competent installers. We are heartily in accord with that sentiment and we know that most of you have made earnest and successful efforts to secure the passage of ordinances requiring the licensing of contractors. We now ask you to use your influence in making such ordinances effective by promptly prosecuting those who fail to live up to the ordinance and, further, by establishing public good will for licensed contractors. It is not enough to pass a law. The law must have the public behind it and the law must have enforcement.

New wiring methods

The National Electrical Contractors Association wishes to put itself on record with the International Association of Electrical Inspectors as being decidedly in favor of progress in the development of our art. We are vitally interested in economies and in new and progressive methods of wiring. It is inconceivable to us that an art such as ours can go on growing year after year without the development of new processes and methods. At the same time our association will not look with favor upon any new method which introduces a new hazard to life or property, which is uneconomical or which materially reduces our standards. It is not enough that a material show some economy in first installation. We insist that the maintenance of the installation also be given consideration in establishing the ultimate economy thereof.

We make this statement particularly as showing our position with respect to bare neutral and concentric wiring. The records of our members from across the Atlantic are undeniably evidence of the costliness of such methods in the long run. The introduction of such methods, in our opinion, would be most decidedly a backward step. Give us greater economies by new wiring methods by all means, but please do not force upon us the use of systems of lower standards whose only apparent advantage is some alleged cheapness.

*From address to convention of International Association of Electrical Inspectors.

READERS' FORUM

Analyzes T.V.A. Proposal

To the Editor of the ELECTRICAL WORLD:

After reading the editorial and the T.V.A. article in your September 23 issue I am prompted to put in my "two cents."

The editorial is timely and right to the point. The wolf is at the door, in fact several packs of them, and every four-legged one has a nice set of sharp teeth in addition to the howl.

Under the suggested T.V.A. domestic rate every household in the Tennessee Valley area would use light, refrigerator, range and water heater. It would be cheaper to do that than pay the price for other forms of energy, provided, of course, that they could dig up enough money to buy the essential utilization equipment.

Now set up the rate on that basis of usage—500 kw.-hr. per month—as compared to existing national average of 50 kw.-hr.:

50 kw.-hr. at	3 cents	1.50
150 kw.-hr. at	2 cents	3.00
200 kw.-hr. at	1 cent	2.00
100 kw.-hr. at	0.4 cent	0.40
Total per month		$6.90

Here the energy increment is 0.4 cent per kilowatt-hour. Deduct that and there is left $4.90 per month to cover the consumer and plant allocation increments. That is $58.80 per annum. Take the utility average net of 10 per cent and we have an investment of $588 for this full-usage domestic customer. It should be noted that this use would return $69 per kilowatt, as against the 1932 return of $58 to the utilities.

Such a customer will integrate on the system, with reasonable restrictions as to type of equipment permitted, at 1.2 kw., so the T.V.A. rate is clearly based on an investment of $490 per kilowatt. According to the utility statistical tabulation you published early this year you will find that back in the normal days of 1930 our existing utilities averaged $480 per cusomer with an average allocation of 1.3 kw. per customer or $370 per kw. Wouldn't our utilities be in a nice pickle if they tried to disprove the T.V.A. set-up and were forced to admit that Lilienthal's figures were one-third higher than their own.

Probably the utilities will say that a full-usage domestic consumer will use more than a 1.2 kw. allocation and will spend millions on expert testimony to prove it. All they need do is collect a few hundred graphic load charts from the scattered existing full-usage consumers, superimpose them and replot an integrated load curve and they will see that, if anything, the value is high rather than low.

This brings us down to the basic energy increment of 0.4 cent per kilowatt-hour. Under conditions as they exist, or will exist, in the Tennessee Valley that is a fair figure for "as, if and when" energy. If the consumers down there are willing to take a chance and keep the old wood stove and a few tallow dips handy they can be satisfied with that energy rate. It runs in my mind that not so many years ago all that part of the country was crying "no water"—perhaps I have it mixed with some other watershed.

Any system depending entirely upon hydro energy and having a pondage whose entire cost is allocated to flood control or irrigation can well afford to sell energy for 4 mills. With few exceptions our existing hydro plants are delivering that energy at between 2 and 3 mills.

Of couse, if the T.V.A. consumers get wise to the fact that 4-mill energy is cheaper than any combustible fuel for space heating there may be some unpleasant surprises. Plant capacity that is required only in cold weather doesn't grow on bushes. For a good many years to come that factor won't hit the T.V.A. proper very hard. They have the existing Muscle Shoals plant, that is as good as already written off the books, to fall back on.

When, however, they talk about the T.V.A. as a national yardstick they are wetter than their valley can ever be. You can't rent office space on the 50th floor and depend upon the "Grace of God and the weatherman" to guarantee up and down transportation. In other words, the T.V.A. is cutting off the yardstick at the right end, but taking so much off that it is of no use to the rest of us. Even at that is it not better than those rate reductions that cut the stick off at the other end, without rime or reason, and leave us with a measuring rod that doesn't start at 1 and "lies" in any position?

S. BINGHAM HOOD,
Consulting Engineer
710 Lee Avenue,
San Leandro, Calif.

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Make Every Stockholder a Missionary

To the Editor of the ELECTRICAL WORLD:

I have just read with immense interest and satisfaction the two articles "Utilities and the New Deal" and "Tell About Taxation," by Philip Cabot and W. C. Mullendore, in your September 30 issue. I have been wondering why I have not seen such frank, true and forceful presentations of this most important national problem before.

I am only a junior in the public utility game, but as a private citizen I am a small investor and my parents before me and also those on my wife's side of the family have always been accustomed to save what they could and invest their savings in what we had always supposed to be the soundest of our American institutions—the public utilities. Why cannot more of our chief executives have the courage to tell their public and their stockholders the plain, frank truth as has Mr. Mullendore?

Those of us who are still receiving any dividend checks at all should be in a particularly tax-conscious frame of mind when we note that little 5 per cent chiseled off must still be accounted for in our income tax returns. Why not include a little reading matter setting forth the utility's plight with the next check to be followed in another three months (if indeed the company will be still paying a dividend by then) by something more general about state income or city tax source if the utility goose is cooked, thus ending its ability to lay even a copper egg!

EDWARD S. ESTY.
40 Dryden Avenue.
Pawtucket, R. I.

Men of the Industry

F. L. Ball Assumes New Executive Duties

Francis L. Ball, vice-president of a number of public utilities under the management of Charles H. Tenney & Company, Boston, Mass., including the properties at Salem, Beverly, Gloucester, Fitchburg, Mass., and Exeter, N. H., has

been elected operating vice-president of the Tenney companies in the North Boston Lighting Properties group. He succeeds to the executive responsibilities of Albert B. Tenney, resigned (ELECTRICAL WORLD, October 7, page 480). In his enlarged sphere Mr. Ball will continue to direct the management of the first-named properties. The additional electric utilities placed under his executive supervision include the Eastern Massachusetts Electric Company, the wholesaling and transmission organization of the North Boston system; Malden Electric Company, Suburban Gas & Electric Company (Revere) and the Haverhill Electric Company. Mr. Ball was formerly resident manager of the Haverhill and Fitchburg companies and is widely known in the New England utility field. All the foregoing utilities are now identified with the New England Power Association group through the purchase of the Tenney company by that organization in 1931.

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EZRA B. WHITMAN, formerly chairman of the Maryland Public Service Commission and since 1925 a member of Whitman, Requardt & Smith, consulting engineers of Baltimore, has recently been appointed chief engineer of the West Penn Electric Company, Pittsburgh. A graduate of Cornell University, Mr. Whitman has devoted much attention to sewerage and water-supply work, serving the city of Baltimore as water engineer and president of its water board from 1906 to 1914. Subsequently he engaged in private consulting practice along sanitary and hydraulic lines. Mr. Whitman was identified with the Public Service Commission of Maryland from 1921 to 1927, serving as chairman in 1925.

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E. C. CRITTENDEN of Ithaca, N. Y., has been appointed assistant director of the U. S. Bureau of Standards in charge of research and testings. Mr. Crittenden was formerly chief of the division of electricity. He is president of the Optical Society of America and a member of the governing board of the American Association for the Advancement of Science.

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M. W. ARTHUR, for twelve years identified with the Northern Ohio Power & Light Company and the Ohio Edison Company and for the past three years connected with the Commonwealth & Southern Corporation in New York, has been appointed assistant general manager of the Consumers Power Company of Jackson, Mich. Mr. Arthur is succeeding D. E. Karn, who was named general manager of the company following the death of C. W. Tippy. He will assume his new duties November 1.

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CHARLES S. BANGHART, one of the leading executives of the Associated Gas & Electric System, has resigned as president and general manager of the Metropolitan Edison-New Jersey companies with headquarters in Reading, Pa., to assume similar duties as head of a new geographic division of properties of the New York State Gas & Electric Company of the system with headquarters in Binghamton. In going to Binghamton Mr. Banghart returns to the city of his early experiences in the public utility business. It was from 1914 to 1918 that he was president and general manager of the Binghamton Railways Company and the Endicott Light & Power Company. He left Binghamton fifteen years ago for Georgia to become manager of the Augusta Aiken Railway & Electric Corporation, in charge of street railway and electric lighting and power properties. In 1923 he moved to Staten Island, N. Y., where he became vice-president and general manager of the Staten Island Edison Corporation of the Associated System. He remained there until four years ago, when he went to Reading.

R. T. Higgins Heads Commissioners Association

Richard T. Higgins, chairman of the Connecticut Public Utilities Commission since 1911, was elected president of the National Association of Railroad and Utilities Commissioners at the annual convention held last week in Cincinnati. A native of Washington, Conn., and a graduate of St. Francis College, Brooklyn, Mr. Higgins received an LL.D. degree from Fordham University and after being admitted to the Connecticut bar in 1890 he began practice

at Woodbury. Subsequently, moving to Winsted, he served as corporation counsel from 1904 to 1912, was a member of the Connecticut House of Representatives in 1909 and served as railroad commissioner of Connecticut 1910-1911.

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OBITUARY

WILLIAM H. HODGES, formerly general manager of the Thomson Electric Welding Company, Lynn, Mass., died at his home in that city October 4 after an illness of four weeks. He was born in Pawtucket, R. I., in 1852, and retired from the Thomson company about seventeen years ago.

•

DR. HERMANN BECKMANN, who was associated for almost thirty years with the Berlin-Hagen Accumulatorenfabrik Gesellschaft, died recently in Berlin at the age of 60 years. Dr. Beckmann was a leading German authority on accumulator manufacture.

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FREDERICK N. BOSSON, electrical engineer for the Calumet & Hecla Consolidated Copper Company, died at his home in Calumet, Mich., October 6, in his 72d year. Mr. Bosson was born in Boston, Mass., and received his education at the Massachusetts Institute of Technology in the class of 1880. After connections with the Massachusetts

Central Railroad and the Thomson-Houston Electrical Company he was employed by the Calumet & Hecla Mining Company as electrical engineer in 1890. He was a fellow of the American Institute of Electrical Engineers.

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WILLIAM C. HEPPENHEIMER, a director of the Public Service Corporation of New Jersey since its formation in 1903, died September 16 in Doctors Hospital, New York, after an illness of several weeks. He was 73 years of age.

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LEON J. BALL, for many years prominent in public utility investment banking circles in eastern Massachusetts, died September 25 in the Wolfeboro, N. H., Hospital, following an automobile accident. He was born in Canada about fifty-five years ago and after a long association with Charles H. Tenney & Company's investment department joined the house of Matthew Lahti & Company, Boston, upon its organization about three years previous to his death.

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NEWTON A. WOLCOTT, president of the Packard Electric Company of Warren, Ohio, died October 13, at the age of 58. Mr. Wolcott developed the Packard company from a small industry to its present position as an outstanding manufacturer of automobile cables. In 1903 he entered its employ as designing engineer, three years later became manager of the company, in 1909 treasurer and in 1916 he was elected president. In 1932 the company was purchased by the General Motors Corporation and Mr. Wolcott continued as the active head. A native of Farmington, Ohio, he was prominent in the industrial life of that section and at the time of his death he was an officer of a score of Mahoning Valley enterprises.

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CHARLES J. MARSH, director of purchases for the General Cable Corporation of New York, died at his home in Upper Montclair, September 25, after a year's illness. Mr. Marsh was born in New York City 71 years ago. Most of his business life was spent in the electrical wire and cable business, though a few of his earlier years were in the service of George Westinghouse in connection with the latter's electric light and power interests in New York City during that period. Mr. Marsh was a former president of the New York Metal Exchange, a vice-president and New York manager for the Standard Underground Cable Company for many years. He was the Standard company's metal buyer and continued in that capacity and as director of purchases for the General Cable Corporation when the former company was taken over and became one of the units of the General Cable Corporation in 1927.

New Equipment Available

Oil-Blast Circuit Breaker

Oil-blast circuit breaker designated as type FK-44B-Y1, which will withstand 10,000 open-close-open operations without requiring any maintenance and 50,000 operations with a minimum of maintenance, has been announced by the General Electric Company. It is particularly recommended for steel mill main roll drive starting and jogging service or for severe-duty applications which require apparatus to withstand frequent operation.

The ratings are: 15,000 volts at either 600 or 1,200 amp., a one-second short-time inrush rating of 60,000 amp., a five-second short-time inrush rating of 50,000 amp. and an interrupting rating of 100,000 kva. Thorough tests have proved that the equipment will perform 10,000 operating cycles of closing and opening 1,200 amp. at 2,300 volts or 1,000 amp. at 6,600 volts without any maintenance, contact reconditioning or oil change. After such service the breaker will still interrupt its rated kva. It is of single-tank construction suitable for mounting on open or in inclosed frameworks.

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MAGNETIC MOTOR STARTING SWITCHES designated type MC have been announced by the Arrow-Hart & Hegeman Electric Company, Hartford, Conn. These starters are available in the usual range of styles and ratings for motors up to 7½ hp., 25 amp.; 25, 40, 50 and 60-cycle currents are provided for in the standard ratings 110, 220, 440 and 550 volts, single and polyphase. These type MC starters provide positive protection for motor, machine and operator, it is claimed.

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MITCHELL SPECIALTY COMPANY, Holmesburg, Philadelphia, announces an electric cord reel adaptable to any standard electric appliance. When clamped to any ironing board or table, one 6-ft. length of cord connects with a wall outlet, while another 6 ft. of cord automatically reels in and out with featherweight tension.

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A THREE-POINT MASONRY DRILL known as the "Rawldrill" has been announced by the Rawlplug Company, Inc., New York. Its three-point construction, it is claimed, makes possible several advantages heretofore unobtainable in masonry drills: It permits resharpening of the drill on any grinding wheel right on the job; the drill has a much longer life, due to the fact that it will drill clean, and the straight parallel sides of the cutting lips insure a more accurate hole.

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New Conduit Developed for Underground Service

Designed to meet the most rigid requirements of underground electrical service the Goodyear Tire & Rubber Company has announced a new type of conduit. One of the features of this Goodyear-Graybar conduit is its high resistance to water absorption, thereby maintaining excellent mechanical characteristics under all conditions and failing to deteriorate in any way when in contact with moisture. Due to its unusually high impact and crushing strengths, breakage is negligible, even at extremely low temperatures. Not only does it have distinct advantages at low temperatures; but in tests at extremely high temperatures the condui does not exude crude oils or impregnating compounds, thereby eliminating the possibility of cables becoming imbedded in the compound of the duct at extreme overload temperatures.

The inside is smooth and glossy, thus providing an ideal cable raceway. As the coefficient of friction is low, cable pulling strains are greatly reduced and longer pulls are possible without danger of abraiding or slipping the lead sheaths of cables, with consequent lower expense for manholes made possible.

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ELECTRIC SOLDER AND MELTING POTS for tinning, dipping, hardening small tools, etc., have been announced by the Newton Junior Corporation, New Haven, Conn. They will melt and keep in a molten condition all metal or materials with a melting point as high as those of tin and solder, it is claimed, and will melt continuously as metal is used and new metal added, or will maintain a constant temperature for long periods.

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ALL-RUBBER LAMP CORD which has advantages over silk or cotton-covered cord for table lamps, extensions, etc., in that it will not ravel and withstands hard usage, has been announced by the General Electric Company. The cord, designated as type SJ-PO, is extremely flexible, and therefore will not kink. The flexible, tinned copper conductors are insulated with 30 per cent rubber compound and the outer jacket is of a compound containing a high percentage of pure rubber.